



SCIENCE 24

Learning Facilitator's Manual



Modules 1-8



**Distance
Learning**

Alberta
EDUCATION

Science 24

LEARNING FACILITATOR'S MANUAL



**Distance
Learning**

Alberta
EDUCATION

Note

This Science 24 Learning Facilitator's Manual contains answers to teacher-assessed assignments and the final test; therefore, it should be kept secure by the teacher. Students should not have access to these assignments or the final test until they are assigned in a supervised situation. The answers should be stored securely by the teacher at all times.

This document is intended for	
Students	
Teachers (Science 24)	✓
Administrators	
Parents	
General Public	
Other	

Science 24
Learning Facilitator's Manual
Modules 1-8
Alberta Distance Learning Centre
ISBN No. 0-7741-0720-0

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The ADLC will send you the latest enhancements and upgrades for your Learning Facilitator's Manual if you return the following registration card to: Alberta Distance Learning Centre, Box 4000, Barrhead, Alberta, T0G 2P0, Attention: Instructional Design and Development.

ADLC Learning Facilitator's Manual Registration Card

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You can help ensure that distance learning courseware is of top quality by letting us know of areas that need to be adjusted. Call the Alberta Distance Learning Centre free of charge by using the RITE line and ask for the Editing Unit. Also, a teacher questionnaire has been included at the back of most Learning Facilitator's Manuals. Please take a moment to fill this out.

We look forward to hearing from you!

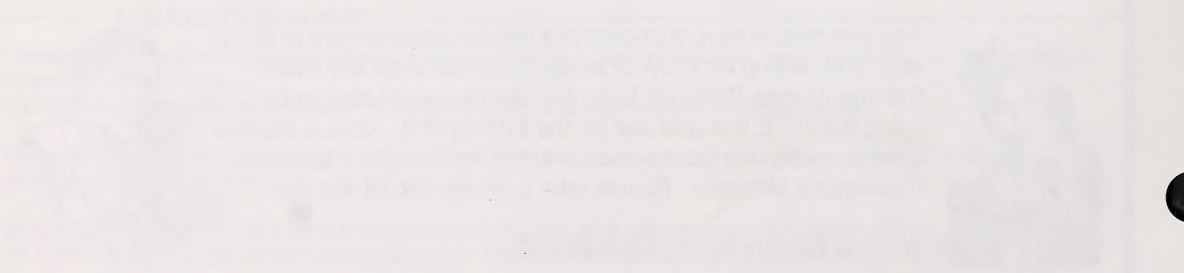


Register with the Alberta Distance Learning Centre

The Alberta Distance Learning Centre is a non-profit organization that provides a wide range of educational services to students across the province. We offer a variety of courses, including English, Math, Science, and Social Studies, at both the high school and post-secondary levels. Our courses are designed to be flexible and accessible, allowing students to learn at their own pace and on their own schedule. We also offer support services, such as tutoring and counseling, to help students succeed in their studies.

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Parent/Guardian E-mail Address	



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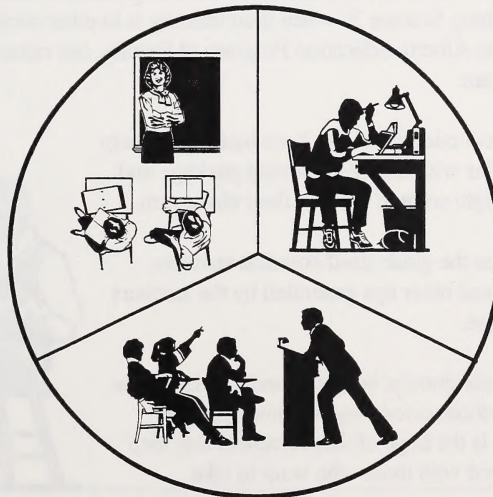
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Introduction

A survey of these course materials will confirm that this new learning package has been specially designed for many kinds of teachers working in a variety of situations.

Which Category Do You Fit?

- ☐ Small Schools Teacher
 - ☐ inexperienced
 - ☐ experienced, but in other subject areas
 - ☐ experienced in teaching Science 24, but wanting to try a different approach
- ☐ Distance Learning Teacher
 - ☐ travelling to schools within the jurisdiction
 - ☐ using facsimile and teleconferences to teach students within the area
- ☐ Larger Schools Teacher
 - ☐ inexperienced
 - ☐ experienced in teaching Science 24, but wanting to try a different approach



Because these materials have been created by experienced classroom teachers and distance learning specialists, they have many advantages for students and teachers regardless of their situations.

Advantages for Students

- incorporates a strong learner-centred philosophy
- promotes such qualities in the learner as autonomy, independence, and flexibility
- is developed through media which suit the needs and circumstances of the learner
- reflects the experiential background of Alberta students
- opens up opportunities by overcoming barriers that result from geographical location
- promotes individualized learning, allowing learners to work at their own pace

Advantages for Teachers

- allows teachers maximum teaching time and minimizes preparation time
- includes different routes through the materials to suit different learners
- incorporates a wide range of teaching strategies, in particular those using independent and individual learning
- delivers curriculum designed by education specialists that reflects the Alberta Education Program of Studies with an emphasis on Canadian content
- provides learning materials which are upwardly compatible with advanced educational technology

Does it sound like something you could use?

This Learning Facilitator's Manual begins with an overview of the current Alberta Education Program of Studies for Science 24. This summary is included for inexperienced teachers or those teachers who have found themselves teaching Science 24 when their training is in other subject areas. This brief summary is not meant to replace the Alberta Education Program of Studies, but rather to help teachers confirm the highlights of the program.

Other parts of this introduction have also been included to help teachers become familiar with this new learning package and determine how they might want to use it in their classroom.

Beyond the introduction the guide itself contains answers, models, explanations, and other tips generated by the teachers who authored this course.

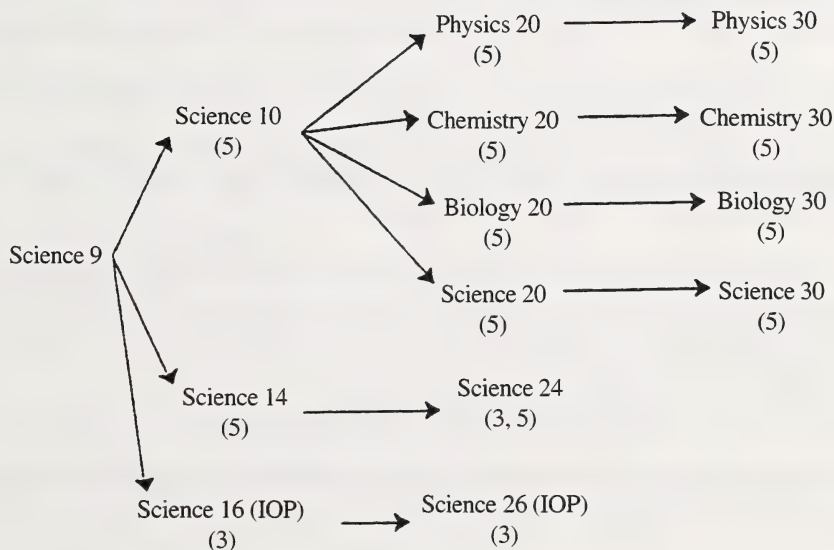
The module booklets, assignment booklets, and LFMs are the products of experienced classroom teachers and distance learning specialists. It is the hope of these teachers that their experience can be shared with those who want to take advantage of it.



Overview of the Program of Studies

The Science 14/24 program is the result of Alberta Education's Secondary Education Review of 1985. The policy set forward by this review established new requirements for high school graduation. High school students are now required to complete a minimum of two science courses (8 credits) to obtain a General High School Diploma. The Science 14/24 program was developed to provide some students with the science component necessary for their General High School Diploma. The old Science 11 course has been replaced by the Science 14/24 program.

The following diagram illustrates the various pathways in the senior high science program.



1

¹ Science 14/24 Teacher Resource Manual, Curriculum Support Branch, June 1989. Reprinted by permission of Alberta Education.

Science 14/24 is an activity-based program which uses the students own experiences to develop attitudes, skills and concepts. Active participation and exploration are used to motivate, to maintain interest and to encourage an appreciation of the relevance also encourages decision-making skills through active investigation of science related issues.

Scientific Literacy

The main goal of the Science 14/24 program is to develop scientific literacy in students. A scientifically literate person has the following characteristics:

- demonstrates a working knowledge and practical understanding of the sciences;
- has the ability to evaluate scientific evidence;
- understands the processes by which scientific knowledge is developed and can adapt those processes for personal use;
- applies science concepts, theories and processes to the investigation of everyday problems;
- understands the relationship between science and technology;
- demonstrates awareness of how science and technology can function responsibly in a social context;
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare; and
- demonstrates a continuing interest in science and technology.

The characteristics of a scientifically literate person form the basis of the four program goals for Science 14/24:

1. Acquire a Foundation of Knowledge in the Natural Sciences
 2. Comprehend the Nature of Science
 3. Understand the Relationship Between Technology and Science
 4. Understand the Role of Science and Technology in Societal Issues¹
-

¹ Science 14/24 Teacher Resource Manual, Curriculum Support Branch, June 1989. Reprinted by permission of Alberta Education.

Science, Technology and Society

The Science 14/24 program was designed to emphasize the interrelationship between science, technology and society (STS). Teaching of science using the STS approach must centre on the development of scientifically literate and responsible citizens, capable of using scientific knowledge wisely, for the good of all members of society. The STS approach to science challenges students by developing scientific literacy through experimentation and investigation. This approach motivates students to learn more about science and to apply what they learn to other situations.

The Science 14/24 program involves life science, physical science, and societal issues. The concepts are introduced through a broad range of experiences, including those based on first-hand experience.

The context is presented with three emphases to indicate the context. Each of these emphases has unique learner expectations associated with it.

(i) Nature of Science (NS)

- the process by which scientific knowledge is gathered Associated with this are the understandings that science is a disciplined way to explain natural phenomena and that scientific knowledge is cumulative and subject to change.

(ii) Science and Technology (ST)

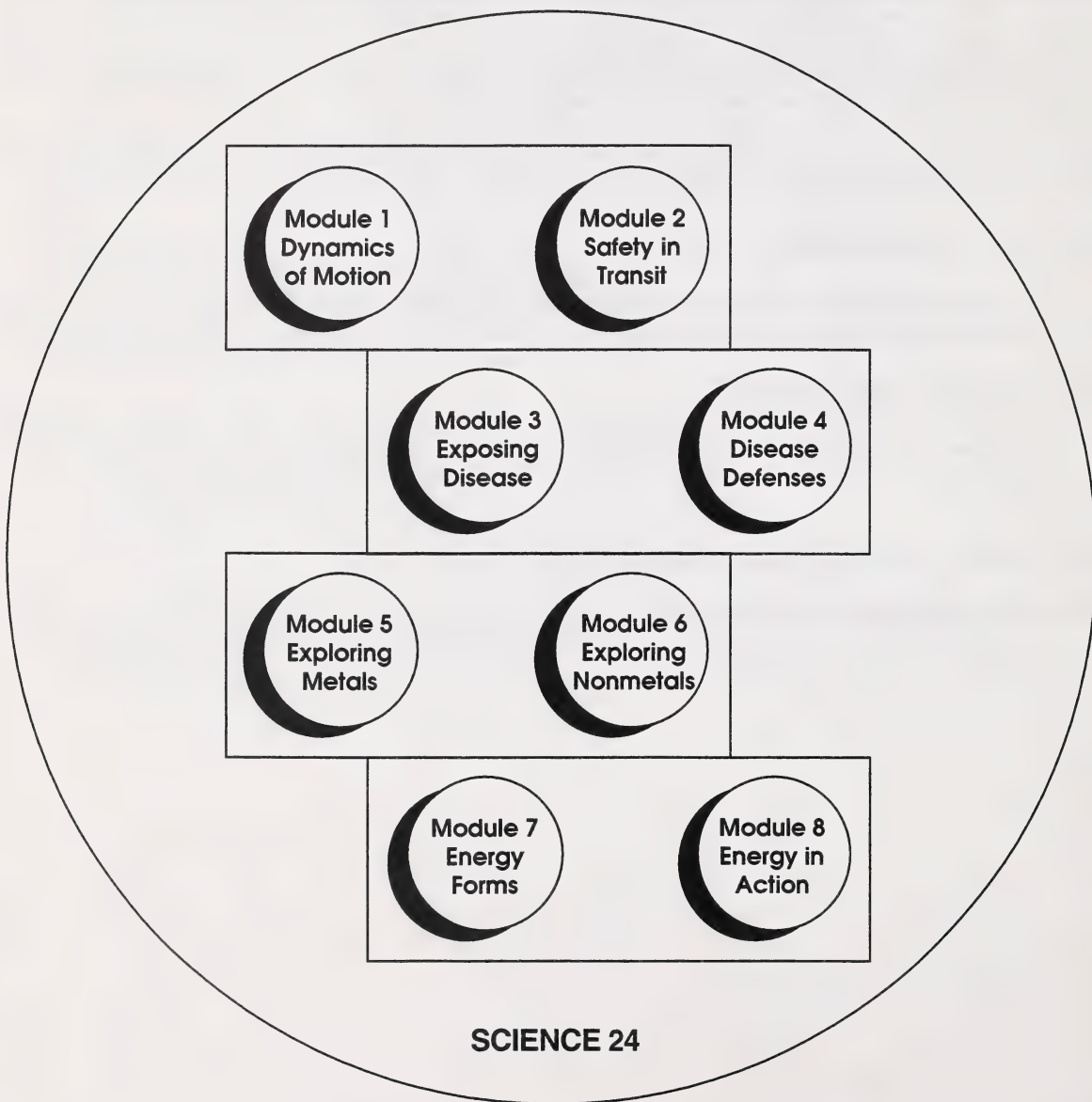
- the application of science to the solution of practical problems Associated with this are the understandings of the interaction between science and technology and the limitations of our present scientific knowledge and technology.

(iii) Science, Technology and Society (STS)

- the implications of science and technology with respect to the individual and society Associated with this are the understandings of how science and technology influence and are influenced by societal issues and the use of appropriate research and communication to examine the societal, technological and scientific aspects of an issue.

Overview of Science 24

The Science 24 course is comprised of eight modules. Each module focusses on a particular science topic using one of the emphases (S, ST, or STS) as a major emphases. Each module, however, also supports learning with the other two emphases. The modules are grouped in pairs to show the four units.

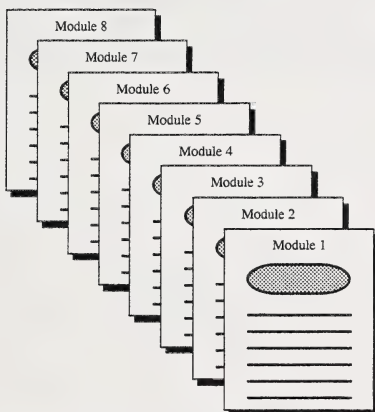


Structure of the Learning Package

Basic Design

This new learning package involves many other components in addition to the Learning Facilitator's Manual.

Modules



The print components involve many booklets called modules. These modules contain guided activities that instruct students in a relevant, realistic setting.

The modules have been specially designed to promote such qualities in the learner as autonomy, independence, and flexibility. Writers have incorporated such teaching strategies as working from the concrete to the abstract, linking the old to the new, getting students actively involved, and using advance, intermediate, and post organizers. Many other techniques enable learners to learn on their own for at least some of the time.

Contents
Overview Evaluation
Section 1 Activity 1 Activity 2 etc.
Section 2 Activity 1 Activity 2 etc.
Section 3 Activity 1 Activity 2 etc.
Section 4 Activity 1 Activity 2 etc.
Module Summary

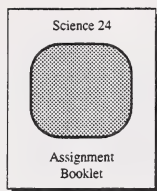
The structure of the module booklets follows a systematic design. Each module begins with a detailed table of contents which shows the students all the main steps. It acts as an organizer for students. The overview introduces the module topic or theme. A graphic representation has been included to help visual learners and poor readers. The introduction also states the weightings of each assignment.

The body of the module is made up of two or more closely related sections. Each section contains student activities that develop skills and knowledge centred around a theme.

The activities may involve print, audio, video, computer, or laser videodisc formats. At times the student and the learning facilitator are allowed to choose the activity that best suits the student's needs and interests. Other activities such as the Extra Help and Enrichment are optional pathways. This flexibility caters to each student's personal situation.

The summary focuses on the skills and strategies that the student has learned.

Assignment Booklet



Accompanying each module is an assignment booklet. The activities in these booklets can be used for formative and for summative assessments. The students should complete these assignment booklets when they have thoroughly reviewed the module materials. The assignment booklets have been designed for classroom use, for faxing, or for mailing. **If the booklets are not being mailed, you should remove the outside cover.**

Media



VIDEOCASSETTE



COURSE
AUDIOCASSETTE
(providing general
teacher guidance)

The package also includes references to media. Pathways have been developed so students can use a variety of media to achieve the objective. These different routes have been included to suit different learners. Wherever video references have been included, a print pathway is also available. This way, if the media resource isn't available or desired, a student can follow the print pathway and still successfully achieve the objective.

A special audiocassette features a teacher guiding the student through the course. The appearance of the teacher icon reminds students that there is this additional help available. If the students are working individually, you may find this cassette a valuable asset. If you are working in a large group, you may wish to guide the students yourself.

Lab and Other Materials



The package includes references to lab materials. A list of necessary materials is included later in this manual.

Materials, Media, and Equipment

Mandatory Components

Equipment (Hardware)	Media	Materials
		<ul style="list-style-type: none">• LFM for Science 24• one complete set of module booklets (8) and assignment booklets (8) for each student• There is no final test.

Optional Components

Equipment (Hardware)	Media	Materials
<ul style="list-style-type: none">• VCR	<ul style="list-style-type: none">• videocassettes <p>Videocassettes used in the course may be available from the Learning Resources Distributing Centre or ACCESS Network. You may also wish to call your regional library service for more information.</p>	<ul style="list-style-type: none">• lab kit for Science 24• loan kit for Science 24
<ul style="list-style-type: none">• audiocassette player	<p>prepared audiocassettes (come with learning package)</p>	

Using This Learning Package in the Classroom

Conventional Classroom

Whether your classroom has desks in rows or tables in small groups, you may be most comfortable with a learning system that you can use with all your students in a paced style. In other words, you may want a package that will suit all of your students, so they can move through the materials as one group or several small groups. Because these materials contain different routes or pathways within each module, they can address various learning styles and preferences. The materials also include many choices within the activities to cater to different thinking levels and ability levels. Because of their versatility and flexibility, these materials can easily suit a conventional classroom.

Open-Learning Classroom

Open learning is the concept of opening up opportunities by overcoming barriers of time, pace, and place by giving the learners a package specially designed to enable them to learn on their own for at least some of the time.

Such a concept is not new. Many teachers can recite attempts to establish an individualized learning system as they recognized the importance of trying to personalize courseware to meet each individual student's needs. But these efforts often failed due to lack of time and lack of quality materials that conformed to Alberta specifications.

Due to advanced educational technology and improved Alberta-specific learning packages, a student-centred approach is now possible. Improved technology now allows us to provide support to learners individually, regardless of their pace or location. A teacher cannot be in twenty-eight places at one time offering guidance. However, media and a well-designed learning package can satisfy individual needs. Technology can also help provide an effective management system needed to track the students as they progress independently through the materials.

The key to a successful open-learning system depends on three vital elements: a learning package specially designed to enable students to learn effectively on their own for at least some of the time; various kinds of learner support; and a management system and style that ensures that the open-learning system runs smoothly.

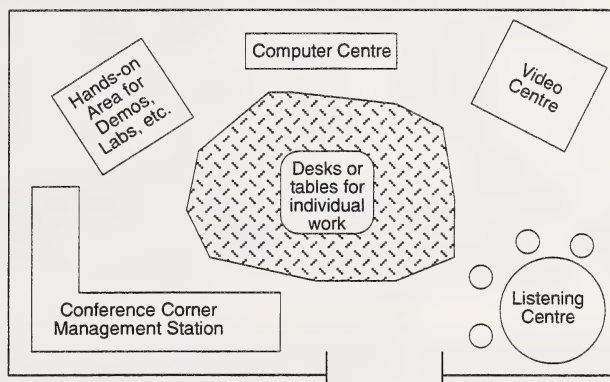
The Key to a Successful Open-Learning System



Learning Package

The specially designed learning package needed for a successful open-learning system has been developed for you. The objectives teach current Alberta specifications using strategies designed for individualized instruction. As the learning facilitator, you need to be sure to have all the components in the learning package available to students as needed.

If adequate numbers of media are available to satisfy the demand, a centre can be established for specific media.



You may not have the luxury to have enough hardware to set up a permanent video or computer centre in your classroom. In that case, students should be encouraged to plan ahead. Perhaps every three to five days they should preview their materials and project when they would need a certain piece of media. This would allow you to group students, if necessary, or reserve media as required.

Support

Support is definitely a key element for successful learning, and when you're planning an individualized, non-paced program, you need to carefully plan when and how support will be given.

The materials contain a form of consistent support by providing immediate feedback for activities included in the module booklet. *High school students have solutions, models, explanations, and guides included in the appendix of every module booklet. These are included so students can receive immediate feedback to clarify and reinforce their basic understanding before they move on to higher levels of thinking.

As the learning facilitator, you may be needed to offer more personal guidance to those students having difficulty, or you may need to reinforce the need for students to do these activities carefully before attempting the assignments in the assignment booklet.

The activities include choices and pathways. If a student is having difficulty, you may need to encourage that student to work on all the choices rather than one. This would provide additional instruction and practice in a variety of ways.

Another form of support is routine contact with each individual. This might be achieved with a biweekly conference scheduled by you, or as students reach a certain point (e.g., after each section is completed), they may be directed to come to the conference area.

Special counselling may be needed to help students through difficult stages. Praise and encouragement are important motivators, particularly for those students who are not used to working independently.

Direct teaching may be needed and scheduled at certain points in the program. This might involve small groups or a large group. It might be used to take advantage of something timely (e.g., election, eclipse, etc.), something prescheduled like the demonstration of a process, or something involving students in a hands-on, practical experience.

Support at a distance might include tutoring by phone, teleconferencing, faxing, or planned visits. These contacts are the lifeline between learners and distance education teachers, so a warm dialogue is essential.

Management

Good management of an open-learning system is essential to the success of the program. The following areas need action to ensure that the system runs smoothly:

- **Scheduling, Distributing, and Managing Resources** – As discussed earlier, this may require a need for centres or a system for students to project and reserve the necessary resources.
- **Scheduling Students** – Students and teachers should work together to establish goals, course completion timelines, and daily timelines. Although students may push to continue for long periods of time (e.g., all morning), teachers should discourage this. Concentration, retention, and motivation are improved by taking scheduled breaks.
- **Monitoring Student Progress** – You will need to record when modules are completed by each student. Your data might also include the projected date of completion if you are using a student contract approach.



Sample of a Student Progress Chart

Course Name		Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Module 8
<i>Billy Adams</i>	P								
	A								
<i>Louise Despins</i>	P								
	A								
<i>Violet Klaissian</i>	P								
	A								
P = Projected Completion Date A = Actual Completion Date									

The student could keep a personal log as well. Such tracking of data could be stored easily on a computer.

- Recording Student Assessments – You will need to record the marks awarded to each student for work completed in each module assignment booklet. The marks from these assignment booklets will contribute to a portion of the student's final mark. Other criteria may also be added (a special project, effort, attitude, etc.). Whatever the criteria, they should be made clear to all students at the beginning.

Sample of a Student Assessment Chart

Course Name	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Module 8	Year's Average
<i>Billy Adams</i>	67	65	54	47	78	67	72	63	64
<i>Louise Despins</i>	43	50	54	55	48	42	60	54	51
<i>Violet Klaissian</i>	65	65	66	68	67	70	74	78	69

Letter grading could easily be substituted.

- Recording Effectiveness of System – Keep ongoing records of how the system is working. This will help you in future planning.

Sample of a System Assessment Chart

Module 1			
Date	Module Booklet	Assignment Booklet	Resources/Media

The Role of the Teacher in an Open-Learning Classroom

The teachers in a conventional classroom spend a lot of time talking to large groups of learners. The situation in open learning requires a different emphasis. Teachers will probably meet learners individually or in very small groups.

With this approach it is necessary to move beyond the idea of a passive learner depending largely on a continually supportive teacher. The teacher must aim to build the student's confidence, to stimulate the learner into self-reliance, and to guide the learner to take advantage of routes that are most meaningful and applicable to the learner.

These materials are student-centred, not teacher-centred. The teacher needs to facilitate learning by providing general support to the learner.

Evaluation

Evaluation is important to the development of every learner. Data gathering and processing, and decision making, at the student and teacher level, serve as means of identifying strengths and weaknesses.

These specially designed learning packages contain many kinds of informal and formal evaluation.

Observation

In the classroom the teacher has the opportunity to see each student perform every day and to become aware of the level and nature of each student's performance.

Observations are more useful if they are recorded in an organized system. The following list of questions is a sample of types of observations and how they can be collected.

Observation Checklist

	B. Adams	L. Despina	V. Klaisian	H. Smith	K. Dalley
1. Does the student approach the work in a positive manner?					
2. Is the student struggling with the reading level?					
3. Does the student make good use of time?					
4. Does the student apply an appropriate study method?					
5. Can the student use references effectively, etc.?					

Observation may suggest a need for an individual interview with a student.

Individual Conferences

Individual conferences may be paced (scheduled) by the calendar, at certain points in the module, or they may be set up only as needed or requested.

During these conferences teachers can determine the student's progress and can assess the student's attitudes toward the subject, the program, school, and self, as well as the student's relationship with other students. With guided questions the teacher can encourage oral self-assessment; the student can discuss personal strengths or weaknesses in regard to the particular section, module, or subject area.

Self-Appraisal

Self-appraisal helps students recognize their own strengths and weaknesses. Through activities that require self-assessment, students also gain immediate feedback and clarification at early stages in the learning process. Teachers need to promote a responsible attitude toward these self-assessment activities. Becoming effective self-assessors is a crucial part of becoming autonomous learners. By instructing, motivating, providing positive reinforcement, and systematically supervising, the learning facilitator will help students develop a positive attitude toward their own progress.

For variation, students may be paired and peer-assessing may become part of the system. The teacher may decide to have the student self-assess some of the activities, have a peer assess other activities, and become directly involved in assessing the remainder of the activities.

When the activities have been assessed, the student should be directed to make corrections. This should be made clear to students right from the start. It is important to note the correct association between the question and the response to clarify understanding, aid retention, and be of use for study purposes.

Many of the activities include choices for the student. If the student is having difficulty, more practice may be warranted, and the student may need to be encouraged to do more of the choices.

Each section within a module includes additional types of activities called Extra Help and Enrichment. Students are expected to be involved in the decision as to which pathway best suits their needs. They may decide to do both.

Self-appraisal techniques can also be introduced at the individual conferences. Such questions as the following might be included:

- What steps are you taking to improve your understanding of this topic?
- What method of study do you use most?
- How do you organize your material to remember it?
- What steps do you follow when doing an assignment in your assignment booklet?
- What could you do to become an even better reader?
- Do you have trouble following directions?
- Did you enjoy this module?

A chart or checklist could be used for recording responses.

Informal Evaluation: Assignments

Informal evaluation, such as the assignments included in each module, are an invaluable aid to the teacher. They offer ongoing assessment information about the student's achievement and the behaviour and attitudes that affect that achievement.

Each module contains a separate booklet called the Assignment Booklet. This booklet assesses the knowledge or skills that the student has gained from the module. **The student's mark for the module may be based solely on the outcome of learning evident in the assignment booklet; however, you may decide to establish a value for other variables such as attitude or effort.** It is important that you establish at the beginning which outcomes will be evaluated, and that all students clearly understand what is expected.

Final Mark

There is no final test for Science 24.

For three credits, any two of the four required units must be completed. This equates to four modules. The final mark may be determined by averaging the marks of the four modules. The value of each module is the decision of the classroom teacher. The following are suggestions only.

Module 1	Module 2	Module 1	Module 2	Module 5	Module 6	Module 3	Module 4	Module 3	Module 4
Module 3	Module 4	Module 5	Module 6	Module 7	Module 8	Module 7	Module 8	Module 5	Module 6

For five credits all eight modules are compulsory. The final mark may be determined by averaging the marks of the eight modules. The value of each module is the decision of the classroom teacher. The following is a suggestion only.

Module 1 13%	Module 2 12%	Module 3 13%	Module 4 12%
Module 5 13%	Module 6 12%	Module 7 13%	Module 8 12%

Introducing Students to the System

Your initiation to these learning materials began with a basic survey of what was included and how the components varied. This same process should be used with the class. After the materials have been explored, a discussion might include the advantages and the disadvantages of learning independently or in small groups. The roles of the students and teacher should be analysed. The necessary progress checks and rules need to be addressed. Your introduction should motivate students and build a responsible attitude toward learning autonomously.

Skill Level

It is important for students to understand that there are certain skills that they will need in order to deal successfully with the course materials. They are listed below:

- understanding and using instructional materials (table of contents, index, list of illustrations, appendices, bibliography, and glossary)
- interpreting maps, graphs, and charts
- using reference materials
- recognizing special symbols
- using a scientific calculator

Other general skills are using reliable study methods, outlining, and learning to read at a flexible rate.

To decide the level and amount of instruction needed to accommodate the varied levels among students, you may wish to prepare and administer skill inventories or pretests. If most students need help with a particular skill, you may want to plan a total class instructional session. If only certain students lack a skill, you may want to set up a temporary skill group to help students who need it, or you may want to develop a skills file for this purpose.

Reading Level

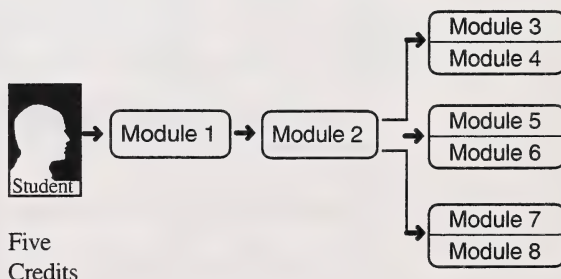
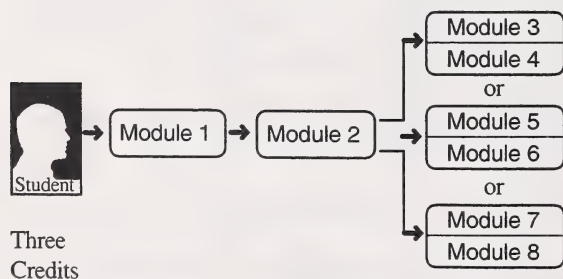
These course materials are largely print based, but poorer readers need not be discouraged. It is important that you assure the students that these materials have been designed for easy reading. The authors have employed special strategies that lower and control the reading level. Some of them are

- the conscious selection of vocabulary and careful structuring of sentences to keep the materials at an independent reading level
- the integration of activities, examples, and illustrations to break text into appropriate-sized chunks
- the inclusion of many kinds of organizers (advance, graphic, intermediate, concept mapping, post organizers) to help give students a structure for incorporating new concepts

- the recognition that vocabulary and concepts are basic to understanding content materials and, thus, must be handled systematically (defined in context, marginal notes, footnotes, and often in a specialized glossary)
- the acknowledgement that background knowledge and experience play a vital role in comprehension
- the systematic inclusion of illustrations and optional videos to help poorer readers and visual learners, and audiocassettes and software as an alternative to print-based learning
- a variety of formats (paragraphs, lists, charts, etc.) to help poorer readers who do not absorb or retain main ideas easily in paragraph format
- the inclusion of media pathways and activity choices to encourage an active rather than passive approach
- instruction in a meaningful setting rather than in a contrived, workbook style
- using purposeful reading, viewing, and doing to produce better interpretation of the course materials
- the recognition that students need structured experiences when reading, viewing, or listening to instructional materials: developing pupil readiness, determining the purpose, providing guided instruction and feedback, rereading if necessary, and extending (This structure closely resembles the reading process.)

To help make the learning package more readable, you can begin your module preparation by reading (viewing, listening to) all the related materials that are going to be used. You need a solid background in order to assess and develop a background knowledge for students. The students' experiential bases may be assessed through brainstorming sessions concerning the topic, or by using visuals and guided questions to predict what the topic might be about.

It is recommended that you start with Module 1 because this module includes basic introductory information. For five credits it is recommended that you end with Module 8 because this module acts as a summary or culmination.



SCIENCE 24

Module 1: Dynamics of Motion



Learning Facilitator's Manual



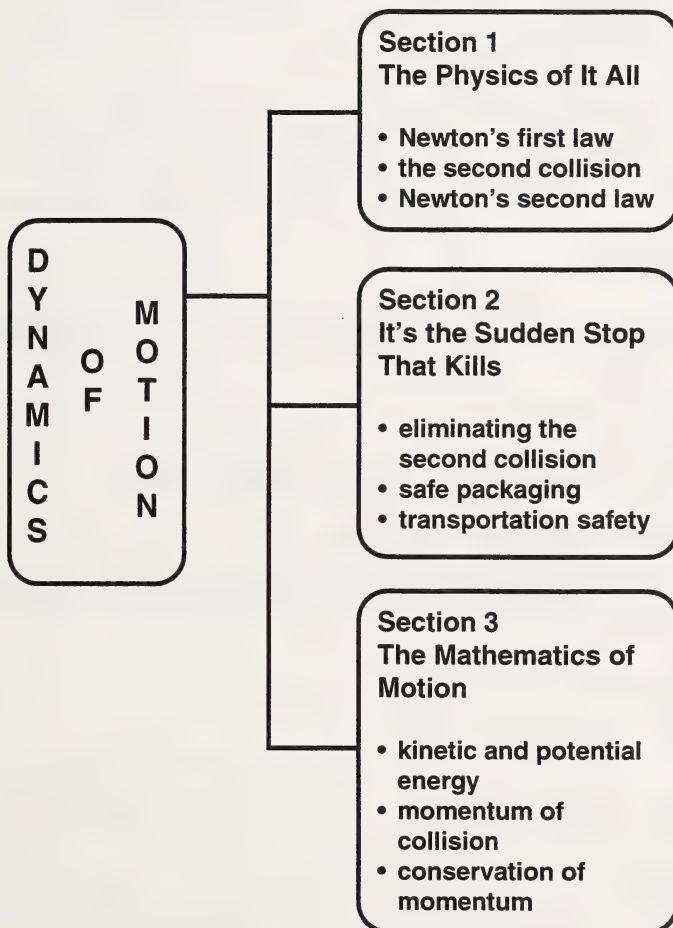
**Distance
Learning**

Alberta
EDUCATION

Module 1: Dynamics of Motion – Overview

The emphasis in this module is on the dynamics of motion. What happens during a collision, the effects of motion, and the transfer of energy will be investigated.

The first and second collision is discussed. Minimizing the risks of motion are also discussed. The module considers motion from both physical and mathematical perspectives.



Materials You Need

The following is a list of materials necessary to complete the investigations and activities in Module 1.

Section 1: Activity 1

- wood or metal ramp (about 1.5 m long and 30 cm wide)
- any small toy car, preferably metal
- modelling clay, plastic putty, or a homemade substitution
- books (to make a stack 40 cm high)
- metric ruler or tape measure
- chalk or erasable marker
- small board to act as a wall or barrier
- masking tape
- table or floor (about 2 m × 2 m in area)
- coin
- playing card
- table top

Note: To make the substitution, combine 250 mL flour, 125 mL salt, 250 mL water, and food colouring.

Section 1: Activity 3

- wood or metal ramp (about 1.5 m long and 30 cm wide)
- books (to make a stack 40 cm high)
- two toy cars of varying mass (284 mL and 400 mL cans of soup or other food could be used instead)
- empty shoe box
- metric ruler or tape measure

Section 1: Extra Help

- cork
- tape
- thread
- wide-mouth jar with lid

Section 2: Activity 1

- raw egg
- empty 2 L milk carton or any similar type of small box
- any materials that could help to eliminate the risk of injury during a second collision (suggested materials could include the following items: popcorn, crumpled newspaper, cloth, cereal, fibreglass insulation, gelatin, chocolate pudding, water, polystyrene, marshmallow, cotton batten, or any other imaginative item)

Section 2: Activity 2

- an empty 1 L milk carton
- 2 cm × 4 cm dummy made from modelling clay
- 30 cm × 10 cm small board
- smooth surface (such as table top or floor)
- thread
- two shoelaces
- balloon

Section 3: Activity 1

- elastic band

Bibliography

The Human Collision Cat. No. T46-13/1976E, Ottawa: Minister of Supply and Services Canada, Canada Government, 1984.

Possible Media

Video *Inertia* (BPN 176801 TV Ontario)

Video *Safety Belts* (VC-26 E Transport Canada)

Video *Speed* (BPN 176803 TV Ontario)

Evaluation

The evaluation of this module will be based on three assignments:

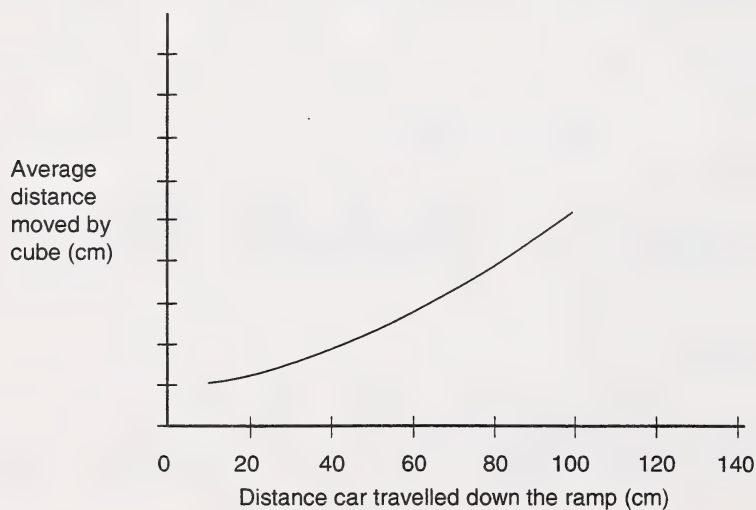
Section 1 Assignment	24 marks
Section 2 Assignment	28 marks
Section 3 Assignment	48 marks
TOTAL	100 marks

Section 1: The Physics of It All

This section investigates the laws of motion. In particular, the laws of motion are applied to the occupants of a car during a crash. Matter and energy, in terms of force and motion, will be used to explain collisions.

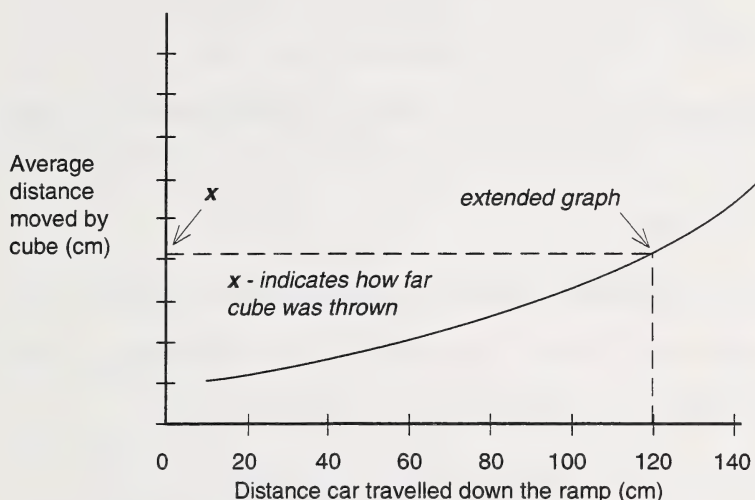
Section 1: Activity 1

1. Complete the following graph using the data from your table.



The graph should rise to the right. As the distance the car travelled down the ramp increased, the distance the cube moved should also have increased.

2. Predict how far the cube would be thrown if the car was released from the 120-cm mark. (Hint: Use your graph to help you make your prediction.) Try releasing the car from the 120-cm mark and compare the result with your prediction.



Extend your graph in a smooth curve in the general direction it is going. Read the prediction from the graph and compare with the actual value you obtained.

3. How does the speed that the car travels affect the distance the cube was thrown?

The greater the speed, the greater the distance the cube was thrown.

4. Explain why you observed different results when the card was pulled slowly compared with when the card was pulled quickly.

The coin follows the card when pulled slowly due to the force of friction. The coin should stay on the table when the card is pulled quickly due to the coin's inertia.

Section 1: Activity 2

1. What action in the diagram illustrates the first collision?

The motorcyclist colliding with the rear of a moving car illustrates the first collision.

2. Suggest a possible second collision that the motorcyclist may experience.

The motorcyclist could be thrown into the car or onto the pavement.

3. In which direction will the motorcyclist be thrown? Why?

The motorcyclist would likely be thrown towards the car as an object in motion stays in motion unless acted upon by an outside force.

4. In which direction will the driver of the car be thrown? Why?

Because an object at rest stays at rest unless acted upon by an outside force, the head of the driver will tend to stay behind the body especially if there is no head rest on the seat. The head appears to go backwards and the result is whiplash, a serious neck injury.

Section 1: Activity 3

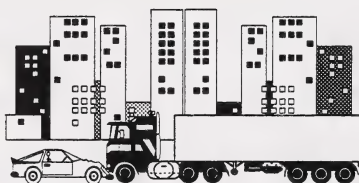
1. How did the mass of the car or can affect the distance the box was moved?

The greater the mass of the car or can, the greater the distance the box was moved.

2. Using your results, state which car or can exerted more force.

The larger car or can exerted more force than the smaller one.

3. Using the following diagram, explain which vehicle will experience the greatest change in motion. Explain why.



The car will experience a greater change in motion as its mass is smaller than that of the truck.

Section 1: Follow-up Activities

Extra Help

1. In which direction does the cork move?

The cork will appear to move in the opposite direction that the jar moved. This is due to its inertia. The cork remains at rest until the jar hits the cork and makes it move. The string may also be pulling the cork.

2. In which direction does the cork move?

The cork moves towards the hand stopping the jar. An object in motion stays in motion unless acted upon by an outside force, namely the hand stopping the motion.

3. In which direction does the cork move?

The cork moves away from you.

Enrichment

1. In which direction does the cork move?

The cork moves in the direction the jar moves. This is opposite to the direction in the empty jar.

2. In which direction did the cork move?

The cork moves away from the hand that stops the jar. Again, this is opposite to the direction in the empty jar.

3. In which direction does the cork move?

The cork moves towards you – again opposite to the direction in the empty jar. The reason that things behave so differently when there was water in the jar can be explained if you think about what happens in a centrifuge. The more dense materials will be thrown further away from the centre. The less dense materials are found closer to the centre. Since the cork is less dense than the water it is closer to the centre and points towards you.

Section 2: It's the Sudden Stop That Kills

This section deals with the first and second collision. It takes a closer look at the second collision in terms of reducing the second collision's impact. A life-saving package used to reduce personal risks is designed.

Section 2: Activity 1

1. Briefly describe the condition of your egg.

Answers may vary depending on container design. Your egg may have survived impact or it may have cracked or become scrambled.

2. If you re-designed your package, how did the results of the second trial compare with the results of the first trial? Why?

Answers may vary. The second trial may be a duplicate of the first or it may be different. The egg may have survived, cracked, or become scrambled. Ideally the second trial should be more successful if using an improved design.

3. If your egg survived, state why it did so. If your egg was broken, state why you think it broke.

Answers may vary. Survival depends on secure packaging to absorb a sound collision safely. Breakage depends on ineffective packaging leading to second collision consequences.

4. Was the second collision eliminated? How can you tell?

The second collision cannot be eliminated, but the consequences can be prevented. If the egg survives, secure packaging prevents damage to the egg by preventing the consequences of a second collision.

Section 2: Activity 2

1. What happened to the dummy when it was not tied in by anything?

The dummy was thrown against the sides of the milk carton when it was free to move.

2. What was one disadvantage about using the thread seat belt?

The thread should have cut into the dummy because the thread is very thin.

3. Which type of seat belt system provided the greatest protection to the passenger – a lap belt or a lap belt and a shoulder belt?

The lap and shoulder belt work best to protect the passenger.

4. What was the function of the balloon in this investigation?

The balloon acted as an airbag – a safety feature found in more and more cars today.

Section 2: Activity 3

1. What hazards can you think of that might be beyond the driver's control?

Some hazards that are beyond the driver's control are weather conditions, the physical condition of the road (i.e., potholes, loose gravel), and wildlife crossing the road.

2. Suggest two ways in which loss of vehicle control due to hydroplaning can be prevented.

Hydroplaning can be prevented by

- *reduced or moderate speed*
- *good tire tread*

3. Winter driving on the Canadian prairies presents a unique challenge for most drivers. Suggest four environmental or natural conditions that are hazardous to winter driving, and briefly explain why they are hazardous.

Winter driving hazards include

- *heavy snowfall which reduces visibility and covers road boundaries*
- *freezing rain which promotes skidding, increases stopping distance, and reduces traction*
- *thick fog which reduces visibility akin to driving blindfolded*
- *extreme cold which is a contributing factor to stalled vehicles*

4. Suggest four environmental or natural conditions that are hazardous to summer driving, and briefly explain why they are hazardous.

Summer driving hazards include

- *dust storms which reduce visibility*
- *heavy downpour promoting skidding, increasing stopping distance, and reducing traction*
- *loose gravel on the road contributing to loss of vehicle control*
- *muddy secondary roads and potholes which promote skidding and loss of vehicle control*

Both summer and winter hazards include night driving with reduced vision, temporary blindness from on-coming headlights, sunrise or sunset, and collisions with animals unexpectedly crossing the road.

5. Suggest four ways in which the actions of other drivers or unexpected circumstances could become a risk to your own safety.

Unexpected circumstances and driver actions include

- *parked or stalled vehicles necessitating evasive action*
 - *slow moving vehicles, farm machinery, and recreation vehicles increase collision risk when attempting to pass them*
 - *loss of vehicle control from alcohol or drug use is often involved in tragic traffic accidents*
 - *collisions with animals unexpectedly crossing*
6. According to the previous table, passenger cars and pickup trucks/vans accounted for almost 90 percent of the total casualty collisions compared with about 5 percent for motorcycles and bicycles. Suggest why there are fewer motorcycle casualty collisions than there are passenger vehicle casualty collisions.

There are probably fewer motorcycles on the highway than there are cars and trucks.

- Using the information from the previous table, which modes of transportation, in terms of the same number of passenger miles, are the safest? Which are least safe?

Scheduled airlines are the safest means of travel and passenger cars are the least safe.

- There are about six times as many car fatalities in the United States as in Canada. What other information would be needed to compare the fatality rate between the two countries?

The population of both countries or the number of vehicles in each country would need to be known.

Section 2: Follow-up Activities

Extra Help

- What does the term *second collision* mean?

Second collision refers to the occupants of a vehicle colliding with the interior of the vehicle.

- Give four technologies developed to reduce the second collision.

Technologies which may reduce effects of a second collision include

- *shoulder and lap belts (seat belts)*
- *air bags*
- *padded interior parts such as dash, doors, steering wheel*
- *collapsing steering wheel*
- *recessed door handles, power windows (no window handles)*
- *head rests (reduce whiplash)*

- Try to think of two ways that vehicles are made to reduce the impact of the first collision.

Vehicle construction that helps reduce the impact of a first collision includes

- *shock absorbing bumpers*
- *accordion frame and panels*
- *very strong side frames (If vehicle was hit from the side, the doors used to cave right into the occupant of the cars which spread the impact over a larger part of the vehicle.)*

Enrichment

- Go back to Activity 1 and design an alternative restraint and test it.

The students' designs will vary as will their results of testing the design.

2. Design a car and illustrate the safety features that are specifically designed for passenger safety.

The students' designs will vary.

3. Research and write a report on child restraints. The body of an infant is different and more fragile than the body of an adult. Find out how a child's body is protected in a collision.

The reports will vary. Ensure that the students' reports give information on the latest child restraints.

Section 3: The Mathematics of Motion

This section deals with the mathematics of motion. The different types of energy are discovered. The application of momentum to moving objects is also discussed and calculated.

Section 3: Activity 1

1. Briefly describe what happened when you released the elastic band.

When the stretched elastic band is released, it moves through a distance.

2. When you stretched the elastic and held it motionless, was the elastic doing any work on your finger as you were ready to shoot it? Explain.

No, the stretched elastic was not doing work because the force was not moving over a distance.

3. When you let the elastic go, there was a small period of time when the elastic pulled its stretched end back to your thumb. Was it doing any work during this time? What was it doing work on? Explain.

Yes, the stretched elastic was doing work. A force moved over a distance as the elastic began to resume its unstretched position.

4. Assume a car is parked on top of a hill. Does the car possess more or less potential energy than a car at the bottom of a hill? Explain.

The car on top of the hill has more potential energy because it has the ability to release more kinetic energy as it rolls down the hill.

5. In a car crash, such as when a car collides with a power pole, is all of the energy transferred to the pole? Explain.

No, some of the car's kinetic energy does work by leaving tire skid marks and producing heat and sound from bending metal when the car hits the pole.

Section 3: Activity 2

1. Predict the direction that the two vehicles will move after the collision.

The two vehicles will move towards the left after impact.

2. Which vehicle has the most momentum in the collision? Why?

The truck has more momentum due to its larger mass.

3. Predict the direction that the two vehicles will move after the collision.

The two vehicles will stop immediately after impact.

4. Which vehicle has the most momentum in the collision? Why?

Neither vehicle has more momentum due to identical speed and mass.

5. Predict the direction that the two vehicles will move after the collision.

The cars will move in the same direction in which the car that has more velocity was travelling.

6. Which vehicle has the most momentum in the collision? Why?

The car travelling towards the left has greater momentum due to its greater speed.

7. In Collision A, why did the truck have a greater momentum than the car if they were both travelling at the same speed?

The truck has a much larger mass than the car.

8. In Collision B, both cars had the same amount of motion with the same mass and velocity. Is it correct to say that both cars had the same momentum? Explain.

Yes, both cars have the same momentum due to identical mass and velocity.

Section 3: Activity 3

1. Predict what will happen to the two cars immediately after impact.

The two cars will stop immediately after impact.

2. Predict what will happen after impact.

The cars will travel towards the left after impact.

3. Calculate the individual momenta before impact.

a. Car A:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 1\,500\text{ kg} \times 60\text{ km/h}$$

$$\text{momentum} = 90\,000\text{ kg}\cdot\text{km/h}$$

b. Car B:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 1\,500\text{ kg} \times (-100\text{ km/h})$$

$$\text{momentum} = -150\,000\text{ kg}\cdot\text{km/h}$$

c. Now calculate the total momentum after impact.

$$\text{total momentum} = \text{momentum of Car A} + \text{momentum of Car B}$$

$$\text{total momentum} = 90\,000\text{ kg}\cdot\text{km/h} + (-150\,000\text{ kg}\cdot\text{km/h})$$

$$\text{total momentum} = -60\,000\text{ kg}\cdot\text{km/h}$$

d. Which direction are the cars going after impact? (Hint: Look at the sign of the total momentum.)

The cars will be travelling to the left due to negative momentum.

4. Calculate the individual momenta before impact.

a. Momentum of Car A:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 2\,000\text{ kg} \times 25\text{ km/h}$$

$$\text{momentum} = 50\,000\text{ kg}\cdot\text{km/h}$$

- b. Momentum of a motorcycle:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 300 \text{ kg} \times (-60 \text{ km/h})$$

$$\text{momentum} = -18\,000 \text{ kg}\cdot\text{km/h}$$

- c. Calculate the total momentum after impact.

$$\text{total momentum} = \text{momentum of car} + \text{momentum of motorcycle}$$

$$\text{total momentum} = 50\,000 \text{ kg}\cdot\text{km/h} + (-18\,000 \text{ kg}\cdot\text{km/h})$$

$$\text{total momentum} = 32\,000 \text{ kg}\cdot\text{km/h}$$

- d. Calculate the velocity and direction after impact.

$$\text{velocity} = \frac{\text{total momentum}}{\text{total mass}}$$

$$= \frac{32\,000 \text{ kg}\cdot\text{km/h}}{2\,300 \text{ kg}}$$

$$= 13.9 \text{ km/h}$$

$$\text{direction of travel} = \text{towards the right due to positive velocity}$$

5. Calculate the following:

- a. momentum of Car A before impact

$$\text{momentum} = m \times v$$

$$\text{momentum} = 2\,500 \text{ kg} \times 30 \text{ km/h}$$

$$\text{momentum} = 75\,000 \text{ kg}\cdot\text{km/h}$$

- b. momentum of Car B before impact

$$\text{momentum} = m \times v$$

$$\text{momentum} = 1\,000 \text{ kg} \times (-70 \text{ km/h})$$

$$\text{momentum} = -70\,000 \text{ kg}\cdot\text{km/h}$$

- c. total momentum after impact

total momentum = momentum of Car A + momentum of Car B

total momentum = 75 000 kg•km/h + (– 70 000 kg•km/h)

total momentum = 5 000 kg•km/h

- d. velocity after impact

$$\text{velocity} = \frac{\text{total momentum}}{\text{total mass}}$$

$$= \frac{5\,000 \text{ kg} \cdot \text{km/h}}{3\,500 \text{ kg}}$$

= 1.4 km/h towards the right due to positive velocity

Section 3: Follow-up Activities

Extra Help

- How much momentum does the car have before colliding with the tree?

$$\text{momentum} = m \times v$$

$$= 2\,000 \text{ kg} \times 90 \text{ km/h}$$

$$= 180\,000 \text{ kg} \cdot \text{km/h}$$

- Since the car is in motion, it has kinetic energy. During the collision, what happens to the kinetic energy of the car?

Some of the kinetic energy of the car is transferred to the tree. The tree can be damaged or even broken. Some of the kinetic energy of the car is used to deform the car (parts are bent or broken).

3. Calculate the following.

- a. momentum of car:

$$\begin{aligned}
 \text{momentum} &= m \times v \\
 &= 2\,000\text{ kg} \times 10\text{ km/h} \\
 &= 20\,000\text{ kg}\cdot\text{km/h}
 \end{aligned}$$

- b. momentum of truck:

$$\begin{aligned}
 \text{momentum} &= m \times v \\
 &= 10\,000\text{ kg} \times (-4\text{ km/h}) \\
 &= -40\,000\text{ kg}\cdot\text{km/h}
 \end{aligned}$$

- c. total momentum after impact:

$$\begin{aligned}
 \text{total momentum} &= \text{momentum of car} + \text{momentum of truck} \\
 &= 20\,000\text{ kg}\cdot\text{km/h} + (-40\,000\text{ kg}\cdot\text{km/h}) \\
 &= -20\,000\text{ kg}\cdot\text{km/h}
 \end{aligned}$$

- d. velocity after impact:

$$\begin{aligned}
 \text{velocity} &= \frac{\text{total momentum}}{\text{total mass}} \\
 &= \frac{-20\,000\text{ kg}\cdot\text{km/h}}{12\,000\text{ kg}} \\
 &= -1.7\text{ km/h}
 \end{aligned}$$

- e. direction of travel:

The negative velocity indicates that the vehicles will be travelling towards the left.

4. Calculate the following.

- a. momentum of Car A before impact:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 2\,000\text{ kg} \times 20\text{ km/h}$$

$$\text{momentum} = 40\,000\text{ kg}\cdot\text{km/h}$$

- b. momentum of Car B before impact:

$$\text{momentum} = m \times v$$

$$\text{momentum} = 1\,000\text{ kg} \times (-40\text{ km/h})$$

$$\text{momentum} = -40\,000\text{ kg}\cdot\text{km/h}$$

- c. total momentum after impact:

$$\text{total momentum} = \text{momentum of Car A} + \text{momentum of Car B}$$

$$\text{total momentum} = 40\,000\text{ kg}\cdot\text{km/h} + (-40\,000\text{ kg}\cdot\text{km/h})$$

$$\text{total momentum} = 0\text{ kg}\cdot\text{km/h}$$

- d. velocity after impact:

$$\text{velocity} = \frac{\text{total momentum}}{\text{total mass}}$$

$$= \frac{0\text{ kg}\cdot\text{km/h}}{3\,000\text{ kg}}$$

$$= 0\text{ km/h}$$

- e. direction of travel:

Zero velocity indicates the vehicles are stopped exactly where they collided.

Enrichment

1. Prepare a short report discussing kinetic and potential energy of a tennis match. Be sure to discuss the energy of the tennis ball, tennis racquets, and the players.

Answers will vary. However any movement by the players, ball, or tennis racket would possess kinetic energy. Potential energy would be present in the ball, tennis racket, or players during the time when there is no movement on their part. This would most likely occur during the split second these objects are at rest or just prior to any movement being made. What may not be apparent is the transformation of energy from one form to another during any of these actions unless photographed in slow motion.

2. Explain, in terms of kinetic and potential energy, why a ball does not bounce as high on a carpeted floor as it does on a concrete or wooden floor.

Using kinetic and potential energy only in the explanation, it would be expected that your answer would include the fact that a carpeted floor absorbs more kinetic energy than a concrete or wooden floor. The ball also loses more potential energy as it bounces from a carpeted floor than from a concrete or wooden floor. Therefore, the ball would not bounce as high. The cycle repeats itself until all energy is spent.

3. Devise your own momentum calculation for a rear-end collision involving two cars travelling in the same direction.

Calculations will vary. You should find that the total momentum will be equal to the sum of the two individual momenta. You should find that the speed of the two cars after the collision is somewhere between the two original speeds. That is, faster than the slower, front vehicle and slower than the faster, rear vehicle.

Key to the Assignment Booklet

Section 1 Assignment (24 marks)

- (6 marks) 1. Using Newton's laws, explain how headrests are beneficial in a car crash. Specify which type of collision headrest is specially designed to provide protection for the car occupant.

Newton's first law states in part that an object at rest will remain at rest unless acted upon by an outside force. The headrest is specifically designed for a rear-end collision because it stops the head from remaining in its original position. Without the headrest, the head would move backwards and could result in a whiplash injury.

- (6 marks) 2. As a bus comes to a stop, the passengers are thrown forward. Using Newton's laws, explain why this occurs.

Newton's first law states in part that an object in motion will stay in motion unless acted upon by an outside force. The people in the bus were in motion, and when the bus comes to a stop, they will continue to be in motion. The bus is the outside force.

- (12 marks) 3. Suppose you decide to weigh yourself inside an elevator. You stand on a bathroom scale and push the **up** button.

- a. Will your weight measured by the scale be more, less, or the same as your actual weight recorded under normal conditions? Explain.

The recorded weight will be more than your actual weight. Your body wants to stay at rest. As the elevator moves up, it exerts a force on you and the scale as you tend to remain where you were at rest. This increase of force against the scale will be recorded as an increased weight.

- b. When you get to the top floor and continue standing on the scale, what will your recorded weight be on the scale when you push the **down** button and start going down? Why?

The recorded weight will be less than your actual weight. Again, the body wants to remain at rest. When the elevator moves down, it is pulled away from your body which tends to remain where it was at rest. Since you are now exerting less force against the scale, this will be recorded as a decrease in weight.

- c. On your way down to the ground floor, the elevator slows to a stop. If you continue standing on the scale, what will your recorded weight be on the scale just before the elevator stops? Why?

The recorded weight will be more than your actual weight, because once your body is in motion it will stay in motion and in effect will "collide" with the scale when the elevator stops. The force exerted by your body against the scale will be recorded as an increased weight.

Section 2 Assignment (28 marks)

- (4 marks) 1. It is said that the second collision kills. Explain why this is true.

When a vehicle comes to a stop as a result of collision, the tendency of the body to continue moving at a high speed would cause a person to strike the windshield, door post, or some other interior frame in order to stop moving. This second collision, involving the occupants of the vehicle, can kill or result in serious injury. The first collision involved the vehicle only.

- (16 marks) 2. Design the safest interior of a car that you can think of. Your design could be a labelled diagram or a written response. Include three safety features that you will focus on and describe the function of each.

Answers should include at least three of the following items or other reasonable suggestions:

- lap belt – keeps you in the seat (top half can move)
- shoulder belt – keeps you in the seat much better
- air bag – keeps you from hitting the dashboard and steering wheel
- padded dashboard – makes the second collision less severe
- headrests – prevent whiplash
- hidden knobs – prevent body penetration

- (4 marks) 3. Using concepts from Section 2, explain why highway accidents are often more serious than those occurring in cities, towns, and villages.

The second collision at highway speeds is much more severe than at slower speeds in cities and towns as the body is in motion at a much higher speed on the highway. When a sudden stop occurs due to a first collision, the body will continue to move at a high speed until a second collision suddenly stops its motion.

- (4 marks) 4. Explain why lap seat belts should be secured properly in a snug, rather than loose, fit. Also explain why lap seat belts should be worn across the hips or pelvis rather than across the stomach or abdomen area?

A seat belt should be snug because if worn loose you end up with the second collision being with the lap belt. The belt should be worn across the pelvis because the bone structure allows the forces of collision to be spread over the largest and strongest body area. The abdomen is not a solid bone area; therefore internal injuries could result when the belt pushes against the softer tissue. Special restraints have also been devised for infants and young children as their bodies lack the development of adults.

Section 3 Assignment (48 marks)

- (12 marks) 1. Think of a rubber ball bouncing on a floor. Using kinetic and potential energy, describe what happens as the ball

- a. falls to the floor

As the ball is falling to the floor, it gains kinetic energy and loses potential energy. The potential energy was converted to kinetic energy.

- b. hits the floor

As the ball hits the floor, the kinetic energy is being transferred to potential energy in the ball as it becomes compressed. Some of the kinetic energy is transferred to the floor.

- c. is at its highest point before falling back down

When the ball is at its highest point, it contains potential energy, due to its position and no kinetic energy.

- (4 marks) 2. How is stopping time affected by the speed of a vehicle? Use the term *kinetic energy* to answer this question.

The faster the speed, the greater the stopping time. The kinetic energy must be reduced to zero by converting it to heat through the brakes and friction between wheels and road.

- (16 marks) 3. A 1000 kg car collides head-on with a 10 000 kg truck. The car is travelling at 60 km/h. The truck is travelling at – 5 km/h.

Calculate the following:

- a. momentum of the car

$$\begin{aligned}\text{momentum} &= \text{mass} \times \text{velocity} \\ &= 1\,000\text{ kg} \times 60\text{ km/h} \\ \text{momentum} &= 60\,000\text{ kg}\cdot\text{km/h}\end{aligned}$$

- b. momentum of the truck

$$\begin{aligned}\text{momentum} &= \text{mass} \times \text{velocity} \\ &= 10\,000\text{ kg} \times (-5\text{ km/h}) \\ \text{momentum} &= -50\,000\text{ kg}\cdot\text{km/h}\end{aligned}$$

- c. total momentum of the car and truck

$$\begin{aligned}\text{Total momentum} &= \text{Momentum of car} + \text{Momentum of truck} \\ \text{Total momentum} &= 60\,000\text{ kg}\cdot\text{km/h} + (-50\,000\text{ kg}\cdot\text{km/h}) \\ \text{Total momentum} &= 10\,000\text{ kg}\cdot\text{km/h}\end{aligned}$$

d. velocity after impact

$$\begin{aligned}
 \text{velocity} &= \frac{\text{total momentum}}{\text{total mass}} \\
 &= \frac{10\,000 \text{ kg} \cdot \text{km/h}}{11\,000 \text{ kg}} \\
 &= 0.9 \text{ km/h (or } \dot{=} 1 \text{ km/h) towards the right}
 \end{aligned}$$

- (16 marks) 4. A 200 kg motorcycle collides head-on with a 2 000 kg car. The motorcycle is travelling at 100 km/h and the car is travelling at -10 km/h.

Calculate the following.

a. momentum of the motorcycle

$$\begin{aligned}
 &= \text{mass} \times \text{velocity} \\
 &= 200 \text{ kg} \times 100 \text{ km/h} \\
 &= 20\,000 \text{ kg} \cdot \text{km/h}
 \end{aligned}$$

b. momentum of the car

$$\begin{aligned}
 &= \text{mass} \times \text{velocity} \\
 &= 2\,000 \text{ kg} \times (-10 \text{ km/h}) \\
 &= -20\,000 \text{ kg} \cdot \text{km/h}
 \end{aligned}$$

c. total momentum of the motorcycle and car

$$\begin{aligned}
 \text{Total momentum} &= \text{Momentum of motorcycle} + \text{Momentum of car} \\
 \text{Total momentum} &= 20\,000 \text{ kg} \cdot \text{km/h} + (-20\,000 \text{ kg} \cdot \text{km/h}) \\
 \text{Total momentum} &= 0 \text{ kg} \cdot \text{km/h}
 \end{aligned}$$

d. velocity after impact

$$\begin{aligned}
 \text{velocity} &= \frac{\text{total momentum}}{\text{total mass}} \\
 &= \frac{0 \text{ kg} \cdot \text{km/h}}{2\,200 \text{ kg}} \\
 &= 0 \text{ km/h}
 \end{aligned}$$

Zero velocity indicates the vehicles are stopped exactly where they collided.

SCIENCE 24

Module 2: Safety in Transit



Learning Facilitator's Manual



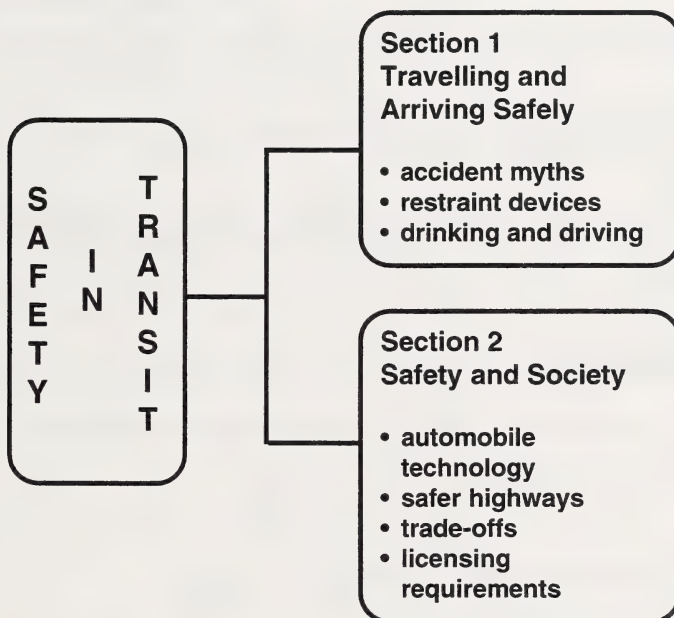
**Distance
Learning**

Alberta
EDUCATION

Module 2: Safety in Transit – Overview

The emphasis in this module is on safe transportation. Demands and expectations raised by society regarding safety concerns are constantly being evaluated. The results are often seen as trade-offs between what society wants and needs and how technology addresses the issue.

Highway safety standards and alcohol involvement in traffic collisions will be identified. How technology attempts to improve and achieve transportation safety will also be considered.



Materials You Need

No special materials are necessary to complete the investigations and activities in Module 2.

Additional Resources

Alberta Traffic Collision Statistics, 1990 (published annually) Alberta Transportation and Utilities, Motor Transport Services, 4999-98 Ave, Edmonton, Alberta, T6B 2X3, (403) 427-7059.

Drive Alive, A New Look At Drinking and Driving and Teens A Teacher's Resource Guide For Senior High School, ISBN #1-55006-068-6 (set), AADAC, 10109-106 St., Edmonton, Alberta, T5J 3L7, (403) 427-4267.

How To Drive Canadian Automobile Association, Alberta Transportation, Transportation Safety Branch, 4998-98 Ave, Edmonton, Alberta, T6B 2X3, (403) 427-7059.

Smashed The Magazine On Drinking and Driving, Road Safety and Motor Vehicle Regulation Directorate, Transport Canada, Ottawa, Ontario, K1A 0N5.

The Human Collision Cat. No T46-13/1976E, ISBN 0-662-11444-2, 1984, Transport Canada, Minister of Supply And Services, Canada, Ottawa, Ontario. (An excellent bibliography source is included.)

Possible Media

Video *Impaired Driving, Making A Difference* (ISBN #1-55006-083X AADAC)

Video *Safety Belts* (VC-26 E Transport Canada)

Possible Information Services

Alberta Transportation Safety Branch
4998-98 Ave, Edmonton, Alberta
T6B 2X3, (403) 427-7059

Alberta Motor Association
11220-109 St
Edmonton, Alberta
T5L 4J5, (403) 474-8785

Alberta Safety Council
 Suite 201, 10526 Jasper Avenue
 Edmonton, Alberta
 T5J 1Z7, (403) 428-7555

Transport Canada
 Western Region Headquarters
 Canada Place
 9700 Jasper Avenue
 Edmonton, Alberta
 (403) 495-3815

Suggested Enrichment Activities

Other activities that the student could benefit from are listed.

- Invite a law enforcement officer to speak on drinking and driving or to demonstrate a breathalyzer unit.
- Invite a speaker from Hero's program, University Hospital, to your school. This multimedia presentation deals with safety and accident victims.
- Invite a speaker from AADAC to speak on drinking and driving by teens.
- Go on a field trip to several auto dealerships to investigate safety equipment in new cars.

Evaluation

The evaluation of this module will be based on two assignments:

Section 1 Assignment	47 marks
Section 2 Assignment	53 marks
<hr/>	
TOTAL	100 marks

Section 1: Travelling and Arriving Safely

This section deals with trade-offs that are made to arrive at safe, workable solutions involving the role of technology in society. The assessment of personal risk in using technology is also discussed. The influence of science and technology on societal issues and decisions regarding transportation technology and safety features is emphasized.

Section 1: Activity 1

The following is a self-test in a true-false format. Place a **T** in the blank if you think that the statement is true. If you think that the statement is false, place an **F** in the blank. If the statement is false, rewrite the statement making it true.

- T 1. On average, one person dies each day on Alberta roadways because of traffic accidents.

For example, 409 people were killed on Alberta roadways in 1990.

- F 2. Your chances of surviving a collision improve if you are thrown out of the vehicle.

Thirty percent of the people who die in car crashes die because they are thrown out of the vehicle.

- F 3. The fatality rate of motorcycle accidents is less than that of cars.

Motorcycle accidents are less common, but the number of fatalities are high when you compare the number of motorcycles to the number of cars.

- F 4. A large number of people who are belted into their cars are killed in a burning or submerged car.

Very few people are killed because of burning or drowning. One study indicates that it is fewer than 0.1 percent of all vehicle accident fatalities.

- F 5. If you don't have a child restraint seat, you should place the child in your seat belt with you.

The child could get crushed by your body weight.

- F 6. You can react fast enough during an accident to brace yourself in the car seat.
You don't have enough time to react even at 50 km/h.
- F 7. Most people die in traffic accidents during long trips.
Most people die within 40 kilometres of their home.
- T 8. A person not wearing a seat belt in your car poses a hazard to you.
The person could be thrown into you if the car is hit from the side or if it overturns.
- F 9. Traffic accidents occur most often on Monday mornings.
Most traffic accidents occur on Friday afternoon.
- T 10. Male drivers between the ages of 16 and 19 years are most likely to be involved in traffic accidents.
This statistic is the basis for insurance companies charging higher rates for young male drivers. Inexperience may be one contributing factor.
- F 11. Casualty collisions are most frequent during the winter months.
July and August had the highest number of fatalities in 1989. September would also be included for 1990.
- F 12. More pedestrians than drivers are killed by cars.
Pedestrians accounted for only 11 percent of traffic fatalities in 1990.
- F 13. The greatest number of roadway fatalities can be attributed to poor driving conditions.
In 1990, 56.8 percent of the casualty collisions occurred on dry or good road conditions compared to 21 percent on snow and ice surfaces.
- T 14. The greatest number of female drivers involved in traffic accidents are between the ages of 16 and 20 years.
Young females are responsible for the greatest number of accidents caused by female drivers.

- T 15. Unrestrained occupant casualties are more likely to be young adults between the ages of 16 and 19.

This age group is the one most likely to be involved in collisions and is most likely not to wear seat belts.

16. The highest number of fatalities in 1989 were recorded between July and August.

Tourist traffic, the number of boats and holiday trailers, long weekends, and vacation periods result in increased roadway traffic during July and August.

17. Most traffic accidents occur on a Friday afternoon.

The start of a weekend traffic rush could result in increased traffic, inattention, and careless driving.

18. Young drivers have a higher accident rate than other age groups.

Young drivers have less driving experience. They could also be more inclined to consider driving as a recreational activity rather than a means of transportation, take unnecessary chances, experiment with alcohol, and misjudge environmental road conditions or the actions of other drivers.

19. A person makes a long trip by car. On the return trip there is a greater chance of having an accident close to the person's place of residence than having an accident far from the place of residence.

Drivers could become impatient as they come closer to home, underestimate unexpected hazards in familiar surroundings or roadways, become more careless by considering the trip to be nearly over, and worst of all, fall victim to fatigue.

20. A higher accident rate is more likely to occur on ideal road conditions rather than on poor ones.

Drivers are more cautious and tend to make necessary adjustments on poor road conditions. They could become overly careless on good road conditions by underestimating speed, stopping distance, and reaction time.

21. Suggest four useful reasons for gathering, recording, and keeping accident statistics on file.

Answers may vary but could refer to statistics used by

- *insurance companies to establish rates and premiums*
- *automobile manufacturers to improve and assess safety features and design*
- *engineers to design safer highways, improve traffic flow on roadways, and modify high-collision risk areas*
- *politicians to establish laws, regulations, and standards aimed at increasing public safety and reducing accident statistics*
- *police and law enforcement groups to protect public interests by identifying dangerous drivers*
- *awareness groups to educate people about transportation safety, risks, and solutions*

22. a. Which year had the highest number of accidents?

The highest number of collisions occurred in 1989.

- b. In which year were the most people killed in traffic accidents?

The highest number of fatalities occurred in 1986.

- c. Propose an explanation that indicates why the year with the greatest number of fatalities is not the year with the greatest number of accidents.

Answers will vary, but the most likely explanations would be that technology has improved safety equipment, more people are wearing the equipment such as seat belts, and roadways have become safer through better design.

23. a. Which was the largest group of people killed in motor vehicle accidents?

Drivers were the largest group killed.

- b. The data seems to suggest that driving a motorcycle is safer than driving a car. Explain.

The data does not take into account the numbers of cars versus the number of motorcycles on the road.

- c. Would it be safe to assume that if all cyclists wore safety helmets the percentage of injured cyclists would fall in the next study?

Yes, helmets protect the heads of people who wear them, and therefore, head injuries should decrease.

24. a. What groups of people are most likely to be involved in motorcycle casualty collisions?

The majority of motorcycle casualty collisions involve male drivers between the ages of 18 and 44 years of age. The highest rate of accidents occurs for drivers between 16 and 19 years of age.

- b. What two groups of people are least likely to be involved in motorcycle casualty collisions?

The groups least likely to be involved in motorcycle casualty collisions are those 55 years of age and over and female drivers.

- c. If females and those people over the age of 55 have the lowest motorcycle casualty collisions, why is it not safe to assume that they are better motorcyclists than males or other age groups?

To make valid comparisons, it would be necessary to take into account an equal number of motorcyclists as well as the numbers of kilometres driven by each age and sex group of motorcycle operators.

25. a. Which sex group had fewer accidents?

Females had a lower collision rate for all age groups.

- b. Provide a possible explanation for the difference.

A possible answer could be with the stereotype that the male is the driver if both a male and a female are in the car. This stereotype is being changed, and perhaps statistics in the future will also change. Another possible answer is that females are better drivers.

- c. If you were working for an insurance company, which age and sex group would you charge the highest rate? Why?

You would charge the male group between the ages of 18 and 19 because they have the highest collision rates and are the higher risk group.

- d. Suggest a possible explanation of why people between the ages of 16 to 21 years are the most likely to be involved in traffic accidents.

Probably the most logical explanation has to do with experience. Young drivers are learning and developing driving habits and skills.

26. a. On which day did the highest rate of collisions occur?

The highest rate of collisions occurs on Friday.

- b. At what time of day was it most dangerous to be on the road? Suggest a possible explanation for this observation.

The most dangerous time of day was between 3:00 p.m. and 6:59 p.m. The most likely explanation is that there are more cars on the road at this time due to most people travelling home after work, commonly known as rush hour.

27. Can poor road conditions be blamed for the majority of accidents in Alberta? Explain.

No, poor road conditions cannot be blamed for the majority of accidents in Alberta. Statistics show that 59.7 percent of fatal collisions and 56.7 percent of injury collisions occurred when surface conditions were dry compared with 19.6 percent of fatal accidents and 21.1 percent of injury collisions when snow and ice conditions were involved.

28. The statistics indicate that an alcohol-related injury tends to be more serious. Propose a possible explanation for this fact.

A possible explanation could be due to reduced control of an automobile by an impaired driver. An impaired driver may not act in a responsible manner before, during, and after the accident, therefore making it a riskier situation.

Section 1: Activity 2

1. a. What is the BAC for a female if she weighs 45 kg and has had four beer over a 3-hour period of time?

The BAC for the female is $203 - 45 = 158$ mg% or 0.158.

- b. How long will it take before the alcohol is completely eliminated from her body?

It will take about 13.5 hours for the alcohol to be totally eliminated, based on a reading of 203 mg% divided by 15 mg% of elimination per hour.

- c. How long will she have to wait before she is legally able to drive with a BAC reading less than 80 mg% or 0.08?

The reading must drop from 203 mg% to 80 mg%, a difference of 123. When divided by 15 mg% of elimination per hour, it would take about 8.2 hours to reach 80 mg% or a 0.08 reading.

2. a. A male student weighing 79 kg had a beer and two rum and colas while watching a football game for two hours. On his way home he was pulled over in a Checkstop. Will he be charged with impaired driving? Explain.

No, the male will not be charged because his BAC is about 45 mg% or about a 0.045 reading.

- b. How long will it take before the alcohol is eliminated from his body?

It will take about 3 h to completely eliminate the alcohol.

3. What is the length of time and the number of drinks it would take for you to become legally impaired?

The answers will vary depending on your sex and body weight. For example, a 0.08 reading for a 79 kg male would be reached when four drinks are consumed in less than an hour. A 57 kg female will reach 0.08 after three drinks in less than an hour.

4. If you are 19 years old and have a BAC of 80 mg%, is your amount of risk higher or lower compared to someone 25 years old with a BAC of 80 mg%? Explain.

According to the graph, a 19-year-old has almost twice the risk of fatality at 80 mg% as a 25-year-old.

5. Suggest two reasons why the risk is so high for people aged 16 to 19 years of age.

There are two main factors why the risk is so high for 16- to 19-year-olds:

The first factor is that people 16 to 19 years old are still learning their driving skills.

The second factor is the lack of experience and large amount of experimentation with alcohol at ages 16 to 19.

6. a. How does drinking affect the person's vision?

Alcohol causes vision to become blurred or turn into double vision.

- b. How does this then affect the person's ability to drive?

People with blurred vision tend to fixate and not scan the road as often. This reduces how well a person can drive and places everybody at greater risk.

7. Explain why a slowing down of reflexes or reaction time increases the danger level of driving a motor vehicle.

If you had to slam on the brakes to avoid a crash, the extra time required to react could make the crash unavoidable if reaction time was slowed.

8. Do you think that the minimum penalties for impaired driving offences are too lenient or too severe? Explain your answer.

Your answer will vary depending on personal preference. Any argument relating to the figures shown is valid for your opinion.

Section 1: Activity 3

1. Answer the following true/false questions. Place a **T** if the statement is true and an **F** if the statement is false. If the statement is false, rewrite it to make it true.

 F a. A Class 5 and a Class 7 licence require a medical examination.

A medical examination is required for a Class 1, 2, and 4 licence. All other classes only require one for the initial application.

 T b. A Class 4 licence is required to operate a two-axle vehicle and trailer not equipped with air brakes.

 F c. A Class 5 licence permits a person to operate a city transit bus.

A Class 2 licence is required to operate a city transit bus.

 F d. A taxi or ambulance driver needs a Class 3 licence.

A Class 4 licence is required to operate a taxi or ambulance.

 T e. A Class 6 licence is required to operate a moped or motorcycle.

 F f. A Class 2 licence requires the driver to own and wear a helmet.

Helmets are required for a Class 6 licence.

 T g. A Class 4 licence permits the driver to operate a pick-up truck.

 T h. A Class 2 licence permits a person to operate a bus with less than twenty-four passengers.

 F i. A Class 7 licence permits a person to operate a school bus.

A Class 2 or 4 licence is required to drive a school bus.

 F j. For a 16-year-old to operate a car independently, a Class 6 licence is required.

A Class 5 licence would be required by a 16-year-old to drive a car unaccompanied.

2. What minimum class of licence in Alberta is required to do the following?

- a. learn to drive a car

A learner's permit requires a Class 7 licence.

- b. drive a car unaccompanied

Unaccompanied car drivers require a Class 5 licence.

- c. operate a farm tractor

Farm tractor operators are unlicensed.

- d. drive a recreation vehicle

Recreational vehicle drivers require a Class 5 licence.

- e. drive all vehicles other than motorcycle

A Class 1 licence permits a person to drive all vehicles except a motorcycle.

- f. operate a kindergarten bus

A Class 2 or 4 licence is required to drive a kindergarten bus.

3. Suggest why medical examinations are required for Classes 1, 2, and 4 licences.

The drivers of vehicles in Classes 1, 2, and 4 are required to have medical examinations because they are either transporting passengers for hire (Class 2 and 4) or operating large, potentially dangerous vehicles (Class 1 and 2).

4. What medical testing is required before a learner's permit is issued?

Vision tests are mandatory for all classes. Monitoring vision of all drivers is very important when dealing with safe transportation.

Section 1: Follow-up Activities

Extra Help

Place a **T** beside the statement if it is true and an **F** if it is false. If the statement is false, rewrite the statement to make it true. If you have any difficulties, go back to the section to help you with your decision.

- F 1. Your chances of surviving a collision are better if you are thrown clear.

It is safer to stay inside the vehicle.
- F 2. The fatality rate of motorcycle accidents is less than that of cars.

There are fewer motorcycles on the road; therefore, there are fewer accidents but the fatality rate is higher.
- T 3. Being a passenger in a car is safer than being a driver.

There are more drivers killed than there are passengers.
- F 4. Male drivers have a lower collision rate than female drivers.

Males have a higher collision rate.
- T 5. Sunday is the safest day to travel.

The least number of accidents occur on Sundays.
- T 6. A very dangerous time to travel is at 5:00 p.m.

Rush-hour traffic has the highest frequency of accidents.
- F 7. Poor weather can be blamed for a majority of the accidents in Alberta.

Most accidents took place on dry pavement.
- F 8. Seat belts don't improve safety.

Injuries and deaths are reduced when seat belts are worn.
- F 9. Alcohol speeds up brain activity.

Alcohol is a depressant; it slows down your brain activity.

- T 10. A first conviction for impaired driving can bring a minimum fine of \$2000.00.

The minimum penalty for a first conviction is \$300.00. The courts can place any amount of fine over the minimum.

Enrichment

1. Prepare a report on drinking and driving. Contact your local library, police department, or use information from AADAC's *Drive Alive* Resource Kit in your school for current information.
2. Survey a group of people about seat belts. Make up a list of arguments for and against seat belts and question them as to whether they agree or disagree. Think of ways in which you could change people's attitudes about wearing seat belts.
3. Using information from *Alberta Traffic Collision Statistics*, or other resources, write a report about motorcycle accident statistics. Your report should also include statistics comparing using a helmet versus not using a helmet.

Answers will vary depending on the availability and use of resources.

Section 2: Safety and Society

The emphasis of this section is on how the automobile has advanced in terms of safety features. Comfort and economy are also discussed. In particular, the seat belt is discussed. How roads have been adapted to become safer is also included.

Section 2: Activity 1

1. Suggest why cars became popular in such large numbers and as rapidly as they did.

Your answers will vary, but could include some or all of the following reasons:

- *Cars were not beyond most people's budgets.*
 - *Cars provided greater freedom of movement.*
 - *Cars were not too complicated to operate.*
 - *Cars are a convenient form of transportation.*
 - *Mass production reduced costs.*
2. For each of the following safety features, state how this technology reduces injuries or fatalities during collision.
 - a. padded dash board and sun visors

Padded dashboards and visors absorb some collision energy and reduce injury.

b. energy-absorbing steering column

Energy-absorbing steering columns will collapse instead of impaling the driver when the front of the car smashes into an object.

c. reinforced door frame

Reinforced door beams help protect you from an object such as a car smashing through the door and crushing you in your seat.

d. safety glass windshields

Safety windshields reduce injuries from shattered glass because they break into rectangular pieces rather than sharp, long shards. They also keep their shape and can prevent you from going through the windshield.

e. safety belts

Safety belts help reduce the second collision.

3. Design your own car that would be as safe as possible. Draw a diagram and point out at least six important safety features of your car. Also state the function of each piece of safety equipment. You may want to look at some of the automotive magazines available in your library for new technologies.

Some other safety features that could be incorporated into the design of your car include

- *energy-absorbing bumpers to help absorb kinetic energy*
- *headrests to prevent whiplash*
- *airbags to stop you from hitting the dashboard or steering column*
- *puncture-proof gas tank*
- *ABS brakes*
- *roll bars incorporated into the frame*
- *flat-resistant tires*

Section 2: Activity 2

1. Suggest three reasons why all car occupants should be encouraged to use restraining devices.

Restraints should be worn by all car occupants because they

- *reduce the second collisions with the vehicle or each other*
- *prevent occupants from being thrown out of the vehicle*
- *increase the chances for surviving during collision*

2. Restraints are sometimes used to belt in an adult and an infant held on the adult's lap. Explain the danger in using this method of restraint.

If there is an accident, an infant or child sitting on the lap of an adult would not be protected during a crash if both are belted in together. In fact, the child would likely be crushed against the seat belt during collision. As a general rule, children should always ride in the rear seat with properly installed child restraints.

3. a. Do seat belts really make a difference? Give a reason for your answer.

Yes, seat belts work. The percentage of people killed who were not belted in was 73.1 percent.

- b. The largest group not wearing seat belts in Alberta is people between the ages of 16 and 19. Why is this such an alarming statistic?

Drivers 16 to 19 years of age are most likely to have an accident; therefore, if they are not restrained they are in a very high risk category.

4. Read the following arguments, and respond either in favour or against the given argument. Give a reason for your answer.

- a. Seat belts can trap you. It's better to be thrown free in a collision.

Being thrown free is twenty-five times more dangerous. In almost any collision, it is far safer to remain inside the vehicle than to be thrown to the pavement, or into the path of other vehicles.

- b. I don't need a seat belt. In case of a collision, I can brace myself with my hands.

There isn't any way your arms and legs can brace you in a collision. The force of impact at just 15 km/h is equivalent to catching a 90 kg bag of cement from a first-storey window.

- c. I just don't believe that I will get in an accident.

You have a great chance of being in a collision. Everyone can expect to be in a crash once every 10 years. For one out of twenty people, it will be a serious crash. For one out of sixty people, it will be fatal.

- d. Seat belts don't prevent injuries; they cause them.

Injuries caused by seatbelts are minor if they occur. Slight bruising or stiffness may be the only result in even a serious crash.

- e. I am a good driver and I have excellent reactions, so I don't need seat belts.

No matter how good a driver you are or how quick you are, you cannot control the actions of others on the road.

- f. If I wear a seat belt, I might be trapped in a burning or submerged car.

Collisions involving submersion or fire are extremely rare. Less than one-half of one percent of all collisions involve these circumstances. If fire or submersion is a factor, you could free yourself if you have a seat belt on. If you did not wear your seat belt, you could be knocked unconscious and suffer the consequences of the fire or submersion.

- g. When I wear my seat belt, I can lean forward and touch my head to the windshield. How can wearing this belt save my life?

Seat belts in today's automobiles are designed for comfort and safety. Under normal use they allow you freedom to move, but during a sudden stop they will lock to keep you in place.

- h. I only need to wear seat belts on long trips or while driving at high speeds.

Eight percent of deaths and injuries occur in cars travelling less than 60 km/h. Seventy-five percent of injuries and deaths occur less than 40 km from the homes of the people involved.

Section 2: Activity 3

For each of the highway safety features, state what the function of these features are or how they may help save lives.

1. guard rails

Guard rails absorb kinetic energy and reduce the chances of the vehicle going over a cliff, into oncoming traffic, or into a dangerous obstacle. They are also made to keep the vehicle to one side rather than veering it out into oncoming traffic.

2. break-away poles

Break-away poles snap off above the base and allow the car to carry on through rather than come to a sudden stop.

3. divided highways

Divided highways are safer in that all the traffic is going in the same direction, therefore reducing the risk of a head-on collision.

4. barrels of life

Barrels of life absorb the kinetic energy of a moving car and gradually slow it down, as opposed to hitting a large pillar that doesn't move.

5. reflective road bumps on centre road line

Since the bumps reflect light, they are easily seen and indicate the sides of the lane. They also make a noise when the tires pass over them so the driver is alerted by a loud noise to the fact that the car is moving out of its lane.

6. large, strategically placed road signs

Large, strategically placed road signs will allow a driver to concentrate on driving and not to searching the area for road signs.

7. overpasses

Overpasses help to keep traffic from entering or leaving a road in a dangerous situation. Most overpasses have ramps for drivers to either slow down or to accelerate safely to merge with existing traffic.

8. rumble strips across the road before a stop sign

The sound of the tires hitting the bumps warns the driver of a stop sign ahead.

9. wider roads

Wider roads provide more room to manoeuvre, pass, and pull over for emergencies.

Section 2: Activity 4

1. The type of seat belt in the street vehicle is a lap and shoulder belt. In the racing car, the driver is held in with a five-point racing harness. Why do you think an ordinary car is not equipped with a racing car harness?

The lap-shoulder belt system is easy to fasten and does a very good job of protecting a person. The racing harness is awkward to put on and to fasten securely. The five-point racing harness restricts movement and is not very comfortable. The inconvenience involved with the racing harness is probably the main reason why it is not found in street cars.

2. Do you think that a seat and belting system like the one shown in the previous photo would be found in everyday street cars? Explain.

No. For everyday driving and activities, this seat and system would be very uncomfortable. To turn on the radio, open the glove box, or adjust the heater or air conditioner would be an impossible feat while being strapped in. A system such as the one shown is designed for a very specific use and ones found in street cars are modified to meet everyday requirements.

3. Keeping in mind the rising costs of automobiles, analyse which type of interior would cost more to manufacture? To answer this question, analyse the previous photos.

The interior of the race car would be more expensive.

4. If you had a racing car with an interior as shown in the photo, how convenient would it be to get into and take it to the corner store to buy groceries? Explain.

A short drive to the corner store would be very inconvenient. Climbing over the reinforcing bars and buckling into the harness would take far too much time. Many cars today do have reinforced doors, but these beams are hidden inside the door itself for convenience.

Section 2: Follow-up Activities

Extra Help

Answer the following true/false questions. Place a **T** if the statement is true and an **F** if the statement is false. If the statement is false, rewrite it to make it true.

- T 1. There were fewer major accidents in the early days of auto travel due to slower speeds.

- F 2. Padded dashboards do not help reduce the risk of injury.

Padded interiors of cars help make the second collision less severe.

- F 3. You have a greater risk of being injured in a new car than in a car 25 years old.

Newer cars have the latest improvements in safety technology.

- F 4. Concrete guard rails are very safe.

Concrete guard rails that don't absorb the kinetic energy of a car can throw the car back into the flow of traffic. The concrete is an immovable object which can cause serious damage. Guard rails that absorb the car's energy will keep the car against the guard rail and slow the car down.

- T 5. Even with all of the safety features of roads and cars, the human element is very important.

Properly trained and licensed drivers are the key element.

Enrichment

1. Survey new cars for safety features. The following chart is an example of a possible survey chart. Circle the number most accurate. You may add other features if you wish.

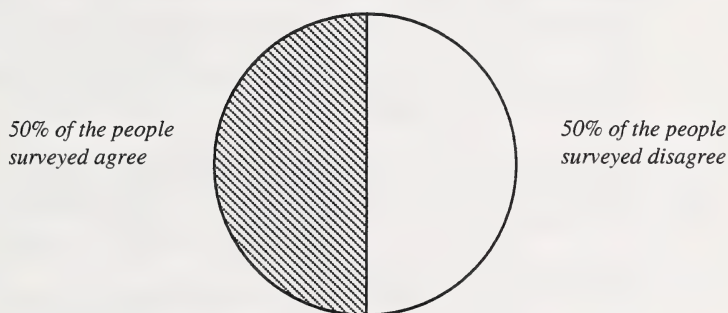
Which Car Is Safest?					
Safety Feature	Least Safe ←————→ Most Safe				
Padded interior	1	2	3	4	5
Air bags	1	2	3	4	5
Head rests	1	2	3	4	5
ABS brakes	1	2	3	4	5
Antiskid drive wheels	1	2	3	4	5
Child-proof safety locks on rear doors	1	2	3	4	5
Reinforced doorframe	1	2	3	4	5
Roll cages	1	2	3	4	5
Puncture proof gas tanks	1	2	3	4	5
Collapsing steering wheel with padded rim and hub	1	2	3	4	5
Daytime running lights	1	2	3	4	5
Recessed door handles	1	2	3	4	5

Your survey data and rating scale could be organized similar to the one shown. Your results will vary depending on the makes and models of cars.

2. Survey at least ten people on the question, “Should the speed limit in Alberta be lowered?” Graph your results on a circle graph.

If five people agree to lowered limits and five people disagree, your circle graph should look similar to the following graph. Other survey results would have a different circle graph.

Should the Speed Limit be Lowered in Alberta?



3. Obtain statistics from Alberta Transportation and do a report on the location of most accidents (i.e. intersections, highways, etc.).

Answers will vary depending on which year the traffic collision statistics are based on. Studies have shown that intersection-related collisions have the largest number of accidents but non-intersection locations should also be included in your report.

Key to the Assignment Booklet

Section 1 Assignment (47 marks)

- (4 marks) 1. The roads are generally dry during the months of July and August, yet during these months the highest fatal collision rates occur. Provide two reasons to explain why.

Answers may vary but may include the following reasons for the high fatality rate.

- *There are more people on the road. People are inclined to travel when the weather is fine rather than when the weather is inclement.*
- *There are more tourists who don't exactly know where they may be going, driving erratically perhaps.*
- *People pulling travel trailers and boats take up more room on the roadways than only cars do.*

- (4 marks) 2. January and February are traditionally cold and snowy in Alberta, yet the number of fatal collisions is low compared to other months. Give two reasons to explain why.

Answers will vary but may include the following reasons:

- *There are less people on the roads therefore making the odds of colliding less.*
- *People may drive slower on the snowy roads, therefore giving them more time to react or correct a mistake.*
- *There may be less tourists on the roads and only seasonal commuters who know where and how the local roadways operate.*

- (4 marks) 3. One argument used by drivers who are against using seat belts is that the driver is already protected by the steering column. The statistics don't support this statement at all. Give two reasons why this argument is not valid against seat belt use.

Answers will vary but may include the following reasons:

- *The driver may be thrown into the steering wheel and injured or killed upon impact.*
- *The statistics in the module show the drivers as having the highest percentage of fatalities; therefore they may need the most protection.*

- (6 marks) 4. Give three reasons why new technology in transportation has led to an increase of serious traffic accidents today compared to 100 years ago.

Answers will vary but may include the following reasons:

- *People are in a bigger rush and are travelling faster, therefore increasing the risk.*
- *Newer technology has built faster cars.*
- *Cars are more affordable because they are mass produced.*
- *People must travel over larger distances, therefore requiring a car; hence, more cars are on the road to crowd traffic.*

Use the data in the following two tables to answer questions 5 and 6. The numbers in the boxes indicate the number of responses given by the two age groups surveyed.

Age Group: 15 to 24				
Statement	Agree	No Strong Opinion	Disagree	
i. I believe people should be fined for not wearing seat belts.	4	1	0	
ii. I wouldn't wear a seat belt if I didn't have to.	3	1	1	
iii. People who don't wear seat belts pose a threat to me when they ride in my car.	2	2	1	
iv. I believe that seat belts save lives.	3	1	1	
v. Seat belts fit poorly, and wrinkle my clothes so I don't wear them.	2	1	2	

Age Group: 25 and over				
Statement	Agree	No Strong Opinion	Disagree	
i. I believe people should be fined for not wearing seat belts.	2	1	2	
ii. I wouldn't wear a seat belt if I didn't have to.	1	1	3	
iii. People who don't wear seat belts pose a threat to me when they ride in my car.	2	1	1	
iv. I believe that seat belts save lives.	4	1	0	
v. Seat belts fit poorly, and wrinkle my clothes so I don't wear them.	3	1	1	

- (10 marks) 5. Explain the reasons as to why there are differences between the age groups for each statement.

Statement i. comparison

People who are over 25 years old have done a majority of their driving before mandatory legislation. They may be less receptive to change.

Statement ii. comparison

Again, people who are over 25 years old may be less receptive to change. Also drivers 15 to 24 years old have been driving with seatbelts since they started driving, so it is second nature with them.

Statement iii. comparison

Both age groups realize that a person inside the vehicle may act as a projectile inside the car.

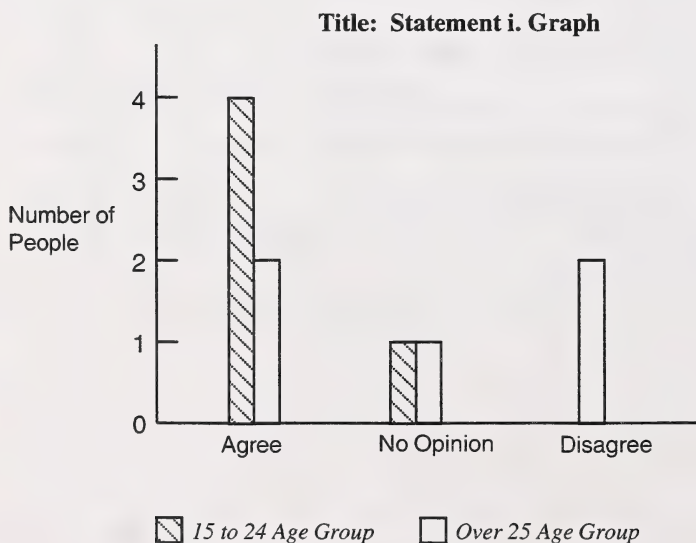
Statement iv. comparison

Both age groups strongly agree that seat belts save lives.

Statement v. comparison

People over 25 years old may have more expensive clothes; therefore this statement may be more powerful for them, hence the stronger Agree response.

- (4 marks) 6. Draw a bar graph of the data for statement i. The responses given by both age groups for statement i must be shown on the same bar graph.



Drinking and driving can have serious consequences. Read the following example involving a high school student and answer the questions that follow in the response page.

It's Friday night. Janice and David were at a party celebrating Janice's seventeenth birthday with a group of friends. David had five beers from 9:00 p.m. until 1:00 a.m.

The group decided to go out for a pizza at 1:30 a.m. and piled into David's car. As they approached the Pizza Place, Janice noticed a police car following them and told David.

David became somewhat distracted as he turned to get a better look. He swerved his car and tried to over-correct but almost missed a stop sign before slamming on his brakes. The police lights flashed and David pulled over.

The police had David walk a straight line and asked him to touch his nose. They also requested that David accompany them to the police station for a breathalyzer test. The rest of group walked to the Pizza Place and sat gloomily as Janice phoned for a cab.

At the police station, David provided two breath samples measuring 0.11 or 110 mg%. He was somewhat surprised but neglected the fact that he only weighs 64 kg. He was charged with a BAC over 0.08 and given a court appearance date.

David's parents arrived at the police station. On the way home they stopped where the offence occurred as David's dad wanted mom to drive the car home. The car had since been towed away as it was left in a bus zone.

David appeared in court with his lawyer and was found guilty of driving with a BAC over 0.08. Since it was his first offence, he was only fined \$300 and was suspended from driving for six months.

At the end of the suspension period, David applied to have his licence reinstated which cost \$20 with a \$140 reinstatement fee. His insurance also increased 50 percent.

adapted from AADAC Drive Alive, page 81

(6 marks) 7. In the space provided, number from 1 to 12 the correct order of the steps taken by the police, court, and insurance company involving David's drinking and driving.

- 6 a. David is charged with driving with a BAC over 0.08.
- 10 b. David is fined \$300 and received a six month licence suspension.
- 3 c. David is taken to the police station for a breath sample.
- 12 d. David's insurance rates increase drastically.
- 8 e. David is issued a notice of appearance.
- 5 f. David's breathalyzer tests reveal a BAC of 0.11.
- 2 g. David is pulled over by police and is asked to walk a straight line and touch his nose.
- 1 h. David displays signs of impaired driving.
- 11 i. David's licence is reinstated.
- 9 j. David appears in court and is found guilty of driving with a BAC over 0.08.
- 4 k. David's car is towed away.
- 7 l. David is released into the custody of his parents.

(4 marks) 8. Explain the costs involved in being arrested and convicted of impaired driving.

Answers may vary but could include financial and inconvenience costs such as the following:

- lawyer fees
- court fine
- increased insurance rates
- reinstatement fees
- time off from work
- finding other means of transportation

(5 marks) 9. Motorcycles account for a much larger fatality and injury collision rate than automobiles.

- a. Explain why the rate is higher for motorcycles than for automobiles.

Automobiles are designed to protect the occupants. A motorcycle leaves the driver and passengers more exposed and with less safety features for protection.

- b. Explain how you could make motorcycles safer to drive. Discuss the technology of the machine and roadways and not the apparel of the driver.

Answers will vary; accept any logical answer that deals with making the motorcycle safer. The following are examples:

- *side rollbars*
- *puncture-proof tires*
- *better windshields*

Section 2 Assignment (53 marks)

- (4 marks) 1. Describe four changes in automobile design that have made cars considerably safer.

Answers will vary, but some possible answers are given:

- *Padded interiors make collisions inside the vehicle less severe.*
- *Structural improvements like shock-absorbing bumpers and reinforced door beams make the car safer.*
- *Very good seat belts keep the driver from colliding with the interior of the car.*
- *Air bags in the dashboard that inflate upon impact give added protection.*
- *More windows allow better vision.*
- *ABS brakes prevent skidding.*

- (10 marks) 2. Choose any two of the following devices found on roadways:

- barrels of life
- break-away poles
- reflective bumps on centre lines
- overpasses

For each device chosen, explain

- how it works
- why it is important to the safety of people using the roadways
- if the cost of the feature makes it a reasonable option

Only two options are needed.

Barrels of life

- *Barrels keep drivers and cars from colliding with pillars or other solid objects.*
- *If there are enough barrels to slow down a car before impact, they are very efficient.*
- *The cost is quite low; empty metal barrels are not expensive and can be purchased second-hand at many places.*

Break-away poles

- *These poles eliminate a collision between a moving car and an unmoveable object. The pole allows the car to continue on and not come to an abrupt stop.*
- *A break-away pole will not stop a moving car; therefore the second collision will be very small.*
- *In 1990, a breakaway pole costs approximately \$1000.00. One thousand dollars is not an extremely high price to pay for a life saved.*

Reflective bumps on centre lines

- *These bumps reflect light, making it easier to see the centre line and stay in your own lane. The also wake up people who may fall asleep.*
- *They are very good at reflecting light, and during periods of low visibility, they may be crucial to seeing where the road is.*
- *They are not very expensive and last for a long time.*

Overpasses

- *Overpasses divert traffic from entering a roadway intersection just for the sake of crossing it.*
- *If there is no traffic crossing the road, the likelihood of collisions is very small. However, it must be noted that the pillars of the overpass itself can cause a safety hazard.*
- *An overpass is a major cost and much thought must go into investigating sites that warrant the expenditure.*

- (6 marks) 3. Riding a bicycle can be a dangerous activity. List and describe the function of three safety features that cyclists could use to reduce the risks.

Answers may vary but possible answers are given:

- *Helmets protect the head from injury.*
- *Reflective pieces on the bicycle as well as on clothing provide easy visibility to motorists.*
- *Bright coloured clothing or reflective vests provide easy visibility.*
- *Bike routes built for cyclists remove the cyclists from the auto transportation corridor and allow for greater safety.*

- (7 marks) 4. New automobile technology is constantly being developed. It seems that whenever a new safety device is invented, it takes many years before most cars have incorporated the technology. Saving lives and reducing injury is important. Explain why new technology in safety devices is not incorporated into all new cars as soon as the technology is developed.

Answers will vary but may include the following ideas. New safety devices would have to undergo many tests before being implemented; this could take a very long time. The cost of the new technology may be too high for automobile companies – the company may wait until the device is mandatory or more inexpensive.

- (21 marks) 5. a. Survey at least ten individuals for their opinions about reducing the highway speed limits in Alberta. Use the chart on the response page to record the total number of individuals who hold each of the opinions.

Statement	Yes	No
i. Highway speed limits should be lowered from the current 100 km/h to 90 km/h.	<i>Answers will vary.</i>	
ii. I believe that lower speed limits will save lives.		
iii. I believe that the public would obey lower speed limits.		

- b. What conclusions can you draw from your survey?

Answers will vary depending on the results of the survey. The conclusions must be drawn from the survey. For example, if nine people surveyed answered “yes” to statement c., then it could be concluded that people think speed limits should be lowered.

- c. Present the results for each of the survey statements by drawing a circle graph for each statement.

There are no correct right or wrong answers. Check the answers given for the following criteria:

- *obtaining data from the survey*
- *each circle graph showing the results (The graphs should be an accurate depiction of what is presented in the survey.)*
- *conclusions drawn from the survey (As long as the conclusions are supported by the survey, they are valid.)*

- (5 marks) 6. Explain how convenience and comfort are a trade-off consideration involving safety features in cars.

Convenience and comfort of all safety features must be considered extensively. The analogy of the very safe race car seatbelt and a safe street car seatbelt shows how comfort and convenience are traded off with safety.

SCIENCE 24

Module 3: Exposing Disease



Learning Facilitator's Manual



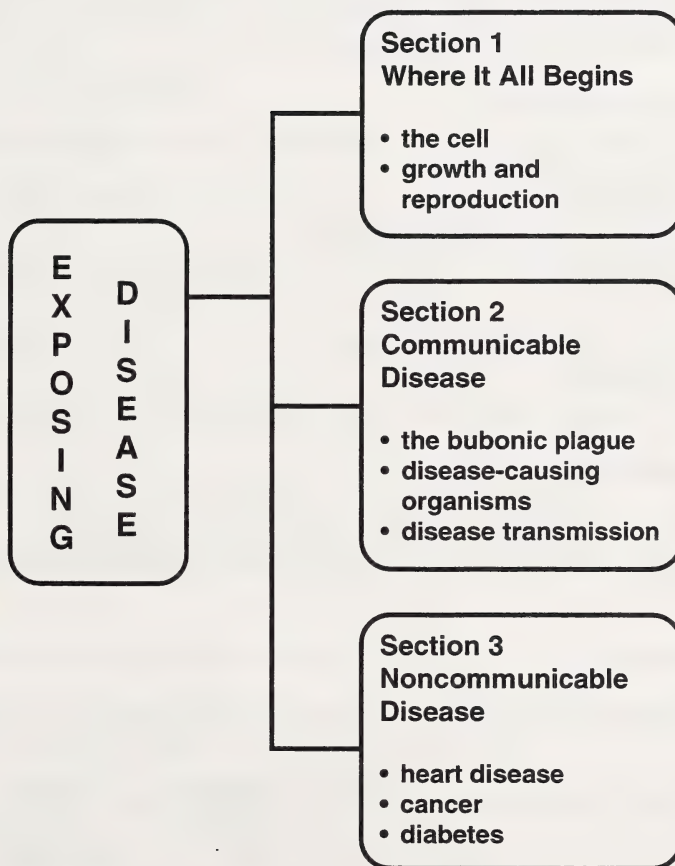
**Distance
Learning**

Alberta
EDUCATION

Module 3: Exposing Disease – Overview

The emphasis in this module is on communicable and noncommunicable diseases using some examples of each to develop the disease concept. The interaction of several factors responsible for transmission of disease is explored.

The basic unit of life – the cell, cell division, and cell theory are introduced to understand how diseases attack the body and how the body responds.



Materials You Need

Section 1: Activity 2

Part A

- compound microscope
- prepared slide of an onion root tip in mitosis

Part B

- microslide viewer
- prepared slide set 53 (animal mitosis) or
- prepared slide set 55 (plant mitosis)

Section 2: Activity 2

- a piece of soft bread
- a sandwich bag
- a hand lens or binocular microscope

Section 3: Activity 1

- a clock that can measure seconds
- a 1 kg object

Possible Media

Video *Introducing Biology: The Cell* (VC328001 ACCESS Network)

Video *Duchenne's Muscular Dystrophy* (VC233001 ACCESS Network)

Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	24 marks
Section 2 Assignment	32 marks
Section 3 Assignment	44 marks
TOTAL	100 marks

Section 1: Where It All Begins

This section deals with the cell as the basic unit of living organisms. It emphasizes basic cell structure and function. It discusses how cells are organized into tissues, organs, and systems. The section also deals with how cells grow, reproduce, and repair themselves.

Section 1: Activity 1

1. Name three kinds of body tissue other than muscles.

Besides muscles, other kinds of body tissue could include bone tissue, blood tissue, nerve tissue, and epithelial tissue which forms the inner lining of the throat, nose, breathing passages, and intestines as well as skin covering.

2. Name six different body organs.

Body organs could include the heart, lungs, liver, stomach, intestines, brain, and kidneys.

3. What body organs form the digestive system?

The body organs that form the digestive system could include mouth, esophagus, stomach, small and large intestines, pancreas, and liver.

4. Name four body systems.

Body systems could include the digestive, circulatory, lymphatic, reproductive, and nervous systems.

5. In what way is a cell similar to an individual brick in a brick building?

The cell is the building block of the body like an individual brick is the building block of a building.

6. What two main ideas are stated in the cell theory?

The cell theory states that cells are the basic units of structure and function in all living things and that they originate from past cells through cell reproduction.

7. In what way do you think the size of your body cells are different from the body cells of a mouse?

Your body cells are the same size as the body cells of a mouse. You have many more cells in your body than does a mouse.

8. State the function of the following cell parts.

a. the nucleus

The function of the nucleus is to act as the control centre for all the activities of the cell.

b. chromosomes

The function of chromosomes is to control heredity through genetic material and traits that are inherited.

9. Although chromosomes have the same basic chemical composition, a different genetic code for each living thing makes them a unique hereditary product. How are the DNA segments in the illustration different from each other?

Each of the DNA segments are different from each other because the sequence and combination of the four different kinds of molecules that pair up to form the rungs are different.

Section 1: Activity 2

1. Predict what could happen if cell division resulted in the daughter cells having a different or an incomplete number of chromosomes compared to the parent cell.

If cell division resulted in the daughter cells having a different or an incomplete number of chromosomes than the parent cell, the individual would acquire an abnormality of some sort.

2. Cancer is caused by an abnormal division of cells that invade surrounding tissue. They are often carried by the blood to other parts of the body, such as organs, where they continue to grow in an uncontrolled fashion. Why is it important to detect cancer before it has a chance to travel to other body locations?

It is important to detect cancer before it has a chance to travel to other body locations in order to localize the abnormal division of cells so that the cancer can be treated and further damage to surrounding tissue or organs can be prevented.

3. What type of cell division results in diseases that are inherited? Why?

Diseases that are inherited are the result of cell division called meiosis. Chromosomes that are responsible for producing disease abnormalities must be passed on from the parent to the offspring for inheritance to occur.

4. In terms of chromosomes, what is the difference between cells formed by mitosis and those formed by meiosis?

The chromosomes in cells formed by mitosis are identical to the parent cell and the same in number. Those formed by meiosis contain half the number of the parent cell from which they are formed.

5. Name some common diseases that are inherited.

Some common diseases that are inherited could include Down's, Turner's, and Klinefelter's syndrome; Duchenne's muscular dystrophy; Huntington's disease; cystic fibrosis; and hemophilia.

6. Can you explain how heart disease can be the result of cells that are formed by mitosis or meiosis?

Heart disease can be the result of cells that are formed by meiosis if the disease is congenital (born with it) or inherited (runs in the family). If it is the result of diet, disease, or accident during a person's lifetime, then mitosis is involved as the cells are replaced.

7. Explain how it's possible for you to inherit a rare blood disease if your parents or grandparents did not have the disease.

Your parents or grandparents had to carry a recessive gene for the rare blood disease in order for you to inherit that trait.

8. What are the symptoms of Down's syndrome?

The symptoms of Down's syndrome are severe mental retardation, thick and enlarged tongue, short broad hands, and weak muscles.

9. Why is a cure not possible for an individual who is born with Down's syndrome?

The extra chromosome is present in every cell of the body of the individual with Down's syndrome. This extra chromosome cannot be removed (at this time) without damaging the cell.

10. Draw as many stages of mitosis as you can find.

Answers may vary, but your drawing should represent any of the stages of mitosis which you viewed through the microscope. They should be similar to some of the stages shown in the illustration in this activity.

11. Draw as many stages of mitosis as you can find.

Your drawing should show the stages of mitosis that you saw through the microslide viewer.

12. In order for a cell to reproduce, it must exactly replicate the chromosome DNA through a complex process. Suggest why it is so difficult to see all the details of the process under magnification using a light microscope.

It is difficult to see all the details of the process of cell division under microscope magnification because the chromosome DNA is extremely small. The light microscope is limited in enlarging the image of small objects to reveal detail. The electron microscope can make larger images but cannot enlarge a living thing without killing it.

13. Suggest why chromosome division is such a complex process.

Chromosome division is such a complex process because an enormous amount of microscopic genetic material must be duplicated exactly if the organism is to grow and stay alive. For example, all the information needed to produce a very complex organism such as a person is contained in the DNA of every cell in the body.

14. If you were not able to see the chromosome genes, how do scientists know that they exist?

Although you were not able to see the chromosome genes, scientists know that they exist because the chromosome can be magnified greatly using an electron microscope showing the genes.

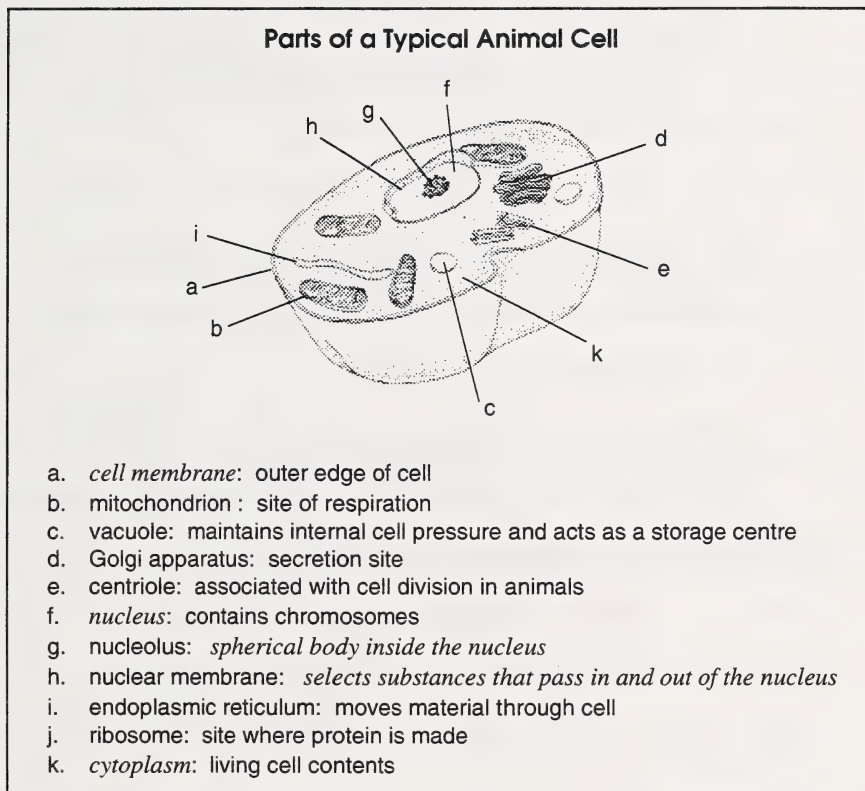
15. Suggest why cell division can be seen only at the tip of an onion root rather than in its upper region.

Cell division can be seen only at the tip of an onion root because the root tip is a region of intensive growth compared to the upper regions.

Section 1: Follow-up Activities

Extra Help

- Fill in the blanks by identifying the missing organelles or description of cell parts.



- Give a definition for the following terms. Provide an example of each.

- cell

A cell is a unit of structure and function of all living things or organisms such as animals' muscle, nerve, and blood cells.

- tissue

A tissue is a group of similar cells that perform the same function such as bone, skin, blood, and nerve tissue.

c. organ

An organ results from several different tissues that perform a certain function by working together such as the heart, lungs, stomach, liver, and intestines.

d. system

A system results when several different organs perform one main function such as the circulatory, digestive, reproductive, or nervous system.

3. Determine which part of a cell does the following.

a. controls everything that enters or leaves the cell

The cell membrane controls everything that enters or leaves the cell.

b. controls all cell activities

The nucleus controls all cell activities.

c. contains organelles or structures that perform many of the cell functions

The cytoplasm contains organelles or structures that perform many of the cell functions.

4. What two substances make up chromosomes?

The two substances that make up chromosomes are DNA and protein.

5. Why are the chromosomes well-defined in Cell B but not in Cell A?

The chromosomes are well-defined in Cell B but not in Cell A because Cell B is preparing to undergo cell division.

6. What is chromatin?

Chromatin is a fine threadlike structure in the nucleus. It is DNA material found in the nucleus.

Enrichment1. View the ACCESS Network video: *Introducing Biology: The Cell* and write a report on the video.

The video should be discussed in terms of cell theory, features, differences, and division.

2. View the ACCESS Network video: *Duchenne's Muscular Dystrophy* and write a report on the video.

The video should be discussed in terms of symptoms, treatment, and genetic implications of Duchenne's muscular dystrophy.

3. Research and write a report on a genetic disease such as Huntington's disease or cystic fibrosis.

Answers will vary, but the report should include the general description, symptoms, treatment, and genetic implications of one of the genetic diseases such as Huntington's disease or cystic fibrosis.

Section 2: Communicable Disease

This section highlights microorganisms as agents that include viruses, bacteria, protists, and fungi which cause disease. It discusses how microorganisms are modes to the transmission of disease. The section also emphasizes how microorganisms had a profound historical significance in causing bubonic plague.

Section 2: Activity 1

1. Use the following percent death rates to calculate the number of people who would die if the bubonic plague hit your community.

Answers will vary depending on the population. Examples are given where the population of the community is 560 people.

- a. 50%

$$50/100 \times 560 = 280 \text{ people would die.}$$

- b. 75%

$$75/100 \times 560 = 420 \text{ people would die.}$$

2. Why was the bubonic plague referred to as the Black Death?

The bubonic plague was referred to as the Black Death because the body was covered with black markings from the disease prior to death.

3. What were the first symptoms of Black Death?

The first symptom of the Black Death was swelling in the groin or armpits.

4. What did people generally call these symptoms?

People generally called these symptoms boils.

5. What did the body look like when it was severely infected with the bubonic plague?

The body would be covered with boils of all sizes. These boils would turn into black or lurid spots.

6. In the Middle Ages people slept on straw on the floor thus giving easy access to the rats and fleas. How would this information connect to the causes of the bubonic plague?

The organisms causing bubonic plague lived in rats, fleas, and finally the human. Since people slept on a straw floor, there would be a greater possible contact with infected rats and fleas.

7. How could you prevent the disease from becoming an epidemic?

To prevent the disease from becoming an epidemic one would have to eliminate any one of the two carriers, namely rats and fleas.

8. Explain two ways in which sleeping in a bed could help to break the plague cycle.

The four-poster bed helped to break the plague cycle in three ways:

- *Rats like to live in straw. Removing the straw reduced the number of rats and fleas living in human houses.*
- *In a room with a floor free from straw it is much easier to see evidence of rats. The rats can be destroyed whenever they show evidence of their presence.*
- *Rats and fleas would have more trouble getting to someone sleeping on a bed compared to someone sleeping on the floor.*

9. Why is death caused by something this tiny so difficult to believe or accept?

It is difficult for most people to accept or imagine that an invisible object could cause so much trouble, because most people must see the evidence for themselves before they can believe in something.

10. Before any communicable disease can be controlled, two factors must be identified. What are they?

Before any communicable disease can be controlled, the two factors that must be identified are how the disease is transmitted and what organism carried the disease.

Section 2: Activity 2

1. Viral diseases can be very different to treat. What is a relatively new viral disease affecting today's human population?

The AIDS disease is caused by a virus. No treatment or cure has yet been found. Most people who are infected with AIDS die.

2. Suggest some reasons why people are not immunized against the common cold, flu, and AIDS.

There are some immunization programs for the flu. The common cold and the flu tend to change very quickly. Each time you get a cold or the flu you are usually getting a new strain of the disease. Your body is ready to fight against the old colds and flus that made you sick before, but your body is invaded by a new cold or flu strain which is not recognized until you are sick. There is evidence that the AIDS virus is also changing very quickly. You cannot be immunized against a virus which keeps changing.

3. A streptococcus throat infection is common. What does the name tell you about the shape of the bacterium?

The shape of the bacterium is round or ball-shaped.

4. What do the words *coccus* and *spirillum* mean?

Coccus means ball; spirillum means spiral.

5. What are the three main shapes of bacteria?

The three shapes of bacteria are: ball or coccus, spiral or spirillum, and rod-shaped or bacillus.

6. Complete the following table that lists the types of organisms that cause specific diseases.

Organism	Diseases Caused
virus	<i>cold</i> <i>mumps</i> <i>small pox</i> <i>rabies</i> <i>polio</i>
bacteria	<i>tuberculosis</i> <i>pneumonia</i> <i>gangrene</i> <i>cholera</i> <i>venereal disease</i>
protist	<i>amoebic dysentery</i> <i>malaria</i> <i>sleeping sickness</i> <i>Oriental Sore</i> <i>kala-azar</i>
fungi	<i>coccidioidomycosis (valley fever)</i> <i>athlete's foot</i> <i>skin rashes</i> <i>lung diseases</i> <i>urinary tract infections</i> <i>ringworm</i>

7. Match the following organisms with their appropriate descriptions.

A. virus

C. bacteria

B. fungus

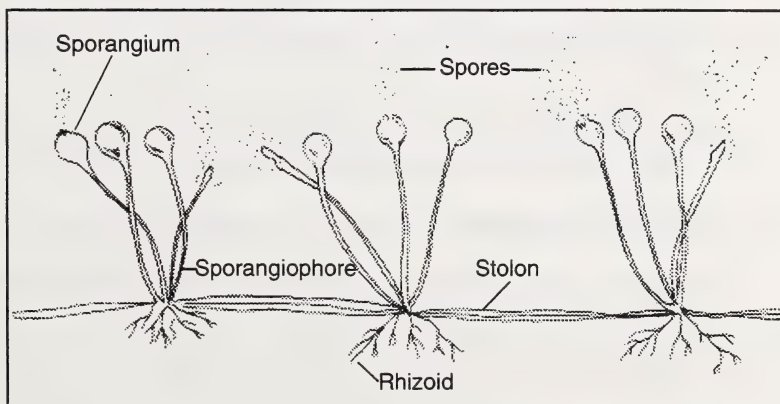
D. protist

- A a. have no life of their own but can reproduce by forcing a cell to produce copies of themselves
- B b. causes athlete's foot
- D c. one-celled organisms without a nucleus
- C d. can be seen with the naked eye

- D e. one-celled organisms that are more complex than bacteria
- A f. cannot be seen with a light microscope
- B g. looks somewhat like a plant
- C h. has three basic shapes
- D i. has the most complex nucleus
- B j. is known as mould

8.

<p>Day 4</p> <p><i>Answers may vary, but you should not notice many changes from Day 3. Some evidence of mould growth should appear on the bread as white threadlike particles. The growth should be greater than Day 3.</i></p>	<p>Day 6</p> <p><i>Answers may vary, but the biggest change would be a larger area of mould growth on the bread.</i></p>
<p>Day 5</p> <p><i>Answers may vary, but the biggest change would be a larger area of mould growth on the bread.</i></p>	<p>Day 7</p> <p><i>Answers may vary, but there should be evidence of a progressive increase in mould growth on the bread. A typical diagram of magnified bread mould may look similar to the following figure.</i></p>



9. Where is the bread mould organism always present or where does it come from?

The bread mould organism is always present in the air. There are many more mould spores in dusty, seldom-cleaned areas.

10. For each diagram indicate if you think it involves a virus, a bacterium, a protozoan, or a fungus.

- | | |
|-------------------------------|------------------------------|
| a. bread: <i>yeast fungus</i> | b. wine: <i>yeast fungus</i> |
| c. penicillin: <i>mould</i> | d. vinegar: <i>bacteria</i> |
| e. yogurt: <i>bacteria</i> | |

Section 2: Activity 3

1. In recent years a number of teenagers have tragically died in Canada from the rapid fatal form of meningitis. What can teenagers do to reduce the risks of meningitis?

For teenagers to reduce the risks of meningitis, they could avoid sharing of food, utensils, drinks, cigarettes with others, and they could avoid kissing.

2. When a person coughs or sneezes in a public place, they should cover their mouth with a handkerchief or tissue. Explain how an infectious disease can be spread by coughing or sneezing.

When a person coughs or sneezes in a public place they should cover their mouth with a handkerchief or tissue to prevent the release of disease organisms into the air. A cough or sneeze expels water droplets which could contain infectious disease organisms into the air.

3. Why should a person with an infectious disease stay away from school or work until they recover?

When a person with an infectious disease stays away from school or work until they recover, they reduce the spread of infectious disease organisms.

4. What other fluids besides saliva may contain infectious organisms?

Other fluids besides saliva, which may contain infectious organisms, could include exhaled water droplets, blood, urine, or semen.

5. How does breathing release disease organisms into the air?

Breathing releases disease organisms into the air through the droplets of water which are exhaled.

6. What groups of people commonly wear face masks? Why?

People who commonly wear face masks may include surgeons, dentists, and laboratory technicians. This is done to prevent the spread of infectious disease organisms.

7. What precautions could a traveller take regarding drinking water or eating fruit or raw vegetables when travelling in foreign countries?

Some precautions that a traveller could take regarding drinking water when travelling to foreign countries may include drinking bottled water, disinfecting drinking water with chlorine tablets or boiling the water before drinking. Avoid raw vegetables and unpeeled fruit because they may have been washed with water which may be contaminated. When you travel, follow the rule that if you can't open it, peel it, or cook it, don't eat it.

8. Why are waterborne infections more common in Third World countries than in developed countries?

Waterborne infections are more common in Third World countries due to lack of a water treatment method which developed countries take for granted. Also water shortages can increase the consumption of contaminated water.

9. Why are swimming pools disinfected with large amounts of chlorine?

Swimming pools are disinfected with large amounts of chlorine to kill infectious disease organisms which could be present due to large numbers of people using the swimming pool, the warm temperature of the water, and the fact that the water is rarely changed.

10. What happens to the microorganisms when your food is properly cooked?

When food is properly cooked microorganisms are destroyed by the heat.

11. A waiter brings you a glass of water and touches the rim of your glass.

- a. What can happen when the waiter touches the rim of a glass?

The waiter can transfer microorganisms from his hand to the rim of a glass.

- b. How should you respond to this kind of service?

You should respond to this kind of service by asking for another glass of water.

12. Why is eating raw or uncooked meat not recommended?

Eating raw or uncooked meat is not recommended due to the microorganisms that are present. You may be aware of the so called "hamburger syndrome" disease which many people get by eating undercooked hamburger, especially during barbecue season.

13. Food poisoning known as salmonellosis is caused by the rod-shaped bacteria called *Salmonella* which can infect people wherever food is served. What are some of the likely causes or sources for this infection and how can it be prevented?

The food poisoning known as salmonellosis could be the result of undercooked or improperly handled food. All foods must be properly cooked. Personal hygiene by staff, cleanliness of food preparation facilities, and proper handling is essential to prevent infection by Salmonella.

14. What are some of the common ways of transmitting disease through direct contact with other people?

Some of the common ways of transmitting disease through direct contact with other people could include kissing, drinking and eating using the same utensils, unprotected sex, and sharing intravenous needles. Others include contact by shaking hands or touching the same objects, and then placing the fingers in the mouth directly or using the hands to eat.

15. Name the insect which carries the following diseases.

- a. the bubonic plague

The flea is the carrier for the bubonic plague.

- b. malaria

The Anopheles mosquito is the carrier for malaria.

- c. African sleeping sickness

The tse-tse fly is the carrier for African sleeping sickness.

Section 2: Follow-up Activities

Extra Help

1. The following is a list of diseases. Write the name of the kind of organism that causes each of the diseases used. (bacteria or virus)

- | | | | |
|-------------------|------------------|-----------------|------------------|
| a. mumps | <u>virus</u> | f. tuberculosis | <u>bacterium</u> |
| b. athlete's foot | <u>fungus</u> | g. gangrene | <u>bacterium</u> |
| c. strep throat | <u>bacterium</u> | h. dysentery | <u>protist</u> |
| d. plague | <u>bacterium</u> | i. beaver fever | <u>protist</u> |
| e. smallpox | <u>virus</u> | j. AIDS | <u>virus</u> |

2. Name five ways in which disease is spread.

Five ways diseases are spread are droplet infection, contact infection, foodborne infection, waterborne infection, and insect-transmitted infection.

3. How are infectious diseases transmitted by the following methods?

- a. droplet

Droplet infections are transmitted by sneezing, coughing, talking, and touching.

- b. waterborne

Waterborne infections are transmitted by drinking contaminated water, bathing or swimming in contaminated water, and eating fruit or raw vegetables that were washed with contaminated water.

- c. foodborne

Foodborne infections are transmitted by handling food with dirty hands, eating improperly cooked food, and by improperly canning or storing food.

- d. contact

Contact infections are transmitted by shaking hands, kissing, sharing intravenous needles, touching objects handled by a diseased person, drinking and eating using the same utensils, and having unprotected sex.

- e. insects

Insect infections are transmitted by being bitten by insects which inject the disease-causing organism into the body.

4. Match the following terms with their appropriate definitions.

<u>iv</u>	a. bacterium	i. carrier of plague
<u>i</u>	b. rat	ii. bubonic plague
<u>iii</u>	c. microscope	iii. magnifies objects
<u>vi</u>	d. virus	iv. staphylococcus
<u>ix</u>	e. malaria	v. a disease caused by a fungus
<u>ii</u>	f. Black Death	vi. cannot be seen with a light microscope

<u>v</u>	g. athlete's foot	vii. sexually transmitted disease
<u>x</u>	h. yeast	viii. disease caused by a virus
<u>vii</u>	i. STD	ix. disease caused by a protist
<u>viii</u>	j. mumps	x. used to make bread

Enrichment

Write an essay on an STD. You can choose one of those named in this section or another of your own choosing. In this essay you should answer the following questions:

1. What are the symptoms of this disease?
2. What organism causes the disease? (Be sure to describe this organism.)
3. What long range effects does the disease cause if it is not treated?
4. Does this disease have a cure? If so, describe it.
5. How is the disease transmitted?

Answers may vary depending on the STD chosen, but you should answer the questions listed.

Section 3: Noncommunicable Disease

This section deals with examples of major noncommunicable diseases in Canada which include the three leading diseases in order of incidence: heart disease, cancer, and diabetes. The section discusses control factors that can lead to prevention of heart disease, and to some extent, cancer and diabetes. Recognition of disease symptoms and life-style changes are also discussed.

Section 3: Activity 1

1. What is the difference between communicable diseases and noncommunicable diseases?

Communicable diseases are transmitted from person to person or from another organism to a person. Noncommunicable diseases are not transmitted; they are inherited or caused by chemicals in the environment.

2. Name three causes of noncommunicable diseases.

Causes of noncommunicable diseases could include heredity, environment, substance abuse, poor eating and exercise habits, and poor personal hygiene.

3. What is the function of the heart?

The function of the heart is to pump blood to all body cells.

4. What is the normal heart beat rate?

The normal heart beat is 60 to 100 beats per minute.

5. What would happen if the flow of blood to the brain was blocked?

If the flow of blood to the brain is stopped, the part of the brain affected would die.

6. What are three conditions that could stop the flow of blood to any part of your body?

The three conditions that could stop the flow of blood to a part of your body are

- *cutting a blood vessel*
- *blocking a blood vessel*
- *stopping the heart*

7. How many times does your heart beat in one minute?

Your answers may vary, but your pulse should be between 20 and 35 beats per twenty seconds. This is multiplied by three to give between 60 and 105 beats per minute.

Here are some sample calculations based on a pulse rate of 60 beats per minute:

<i>beats in one minute</i>	$20 \times 3 = 60$
<i>beats in one hour</i>	$60 \times 60 \text{ min/hr} = 3600$
<i>beats in one day</i>	$3600 \text{ beats/hr} \times 24 \text{ hr/day} = 86\,400$
<i>beats in one year</i>	$86\,400 \text{ beats/day} \times 365 \text{ days/yr} = 31\,536\,000$

8. How many times per minute does your heart beat after the strenuous exercise?

You should notice your pulse increase after the exercise to 100 beats per minute or even more.

9. Were you able to lift the object as many times per minute as your heart beat?

The number of times you are able to lift a one kilogram object from the side of your leg up to eye level in one minute will vary from person to person. You probably will have difficulty doing this exercise as fast as your heart is able to pump blood.

10. Describe the relationship between exercise and heart rate.

Your heart rate varies according to body activity. The harder you exercise, the faster your heart rate. This is because your muscles require more food and oxygen and they also need to eliminate more wastes.

11. What is the difference between a heart attack and a stroke?

When the flow of blood is stopped to the heart, a heart attack occurs. When the flow of blood is stopped to the brain, a stroke results.

12. What are the two types of blockages in blood vessels?

The two types of blockage are blood clots and atherosclerosis.

13. How could you reduce the risk of atherosclerosis?

To reduce the risk of atherosclerosis a person could restrict the amount of fatty foods and cholesterol consumed.

14. What is the ratio of deaths caused by atherosclerosis to the deaths caused by hypertension?

Forty-five times more people die from atherosclerosis than from hypertension. Atherosclerosis is defined as the buildup of minerals and cholesterol in blood vessels.

15. What is blood pressure?

Blood pressure is a measure of the force exerted by blood against an artery. It is written as the highest blood pressure over the lowest blood pressure.

16. What is normal blood pressure?

Normal blood pressure is 120/80.

17. If your blood pressure is high, what is one way of lowering it?

If your blood pressure is high, it may be lowered by decreasing stress or the amount of salt you consume.

18. Where does cholesterol originate?

Cholesterol originates in animals because it is produced by the liver.

19. A person who smokes two packs of cigarettes a day has a higher risk of a heart attack than a nonsmoker. What other risks do smokers face?

Lung cancer is another risk that smokers face.

20. Can a person do anything to reduce heart problems when heart disease clearly runs in the family?

When heart disease clearly runs in the family a person should get regular medical checkups and avoid factors that contribute to heart problems.

21. How does an overweight person place more strain on their heart?

Being overweight places a greater strain on the heart because it must pump more blood to a larger body than the heart's size was designed for.

22. Why is a lack of regular exercise a contributor to heart disease?

Regular exercise strengthens the heart muscle. An out-of-shape heart can easily be overloaded.

23. What treatment can people with diabetes follow to reduce heart disease?

People with diabetes should follow a prescribed diet, take insulin, and exercise regularly to reduce heart disease.

24. a. What are some common stresses that adults experience?

Your answers might include work and marital or economic stresses experienced by adults.

- b. What are some common stresses that teenagers experience?

School-related pressures and stress, peer or family pressures, loss of family or friends, and uncertain futures are some examples of teenage stress.

25. List the nine factors that contribute to heart disease.

Factors that can contribute to heart disease include atherosclerosis, high blood pressure, high cholesterol levels, smoking, heredity, obesity, lack of exercise, diabetes, and severe physical strain or stress.

26. Using the list from the previous question, determine which factors you can control and which factors you can't control.

Factors You Can Control	Factors You Cannot Control
<ul style="list-style-type: none"> • atherosclerosis • cholesterol • smoking • obesity • exercise • severe physical strain or stress 	<ul style="list-style-type: none"> • high blood pressure • heredity • diabetes

27. a. Circle the place where you fit on the graph.

Hopefully you don't have more than three of the risk factors (or you would be off the graph with more than six times the chance of a heart attack).

- b. Extend the graph to where you think it will go if you were to add a fourth factor.

The graph should be extended to where you think it will go if you were to add a fourth factor.

- c. What risk factors, if any, can you remove that you have control over?

You could remove whatever risk factors you have identified over which you have control.

28. Can you name any other medical or surgical procedures designed to deal specifically with heart disease and related factors?

Other medical or surgical procedures designed to deal specifically with heart disease and related factors could include bypass surgery, heart transplants, and drugs.

29. Why is removing unnecessary risk factors the easiest solution to heart disease?

The easiest solution to heart disease is to remove unnecessary risk factors because it is less costly and not as risky as the alternatives for treatment.

Section 3: Activity 2

1. Compare the survival rate for a patient in 1990 to one in 1925.

The ratio is about 60:15 which is about four times as many cancer patients who survived in 1990 compared to 1925.

2. Assuming that the recovery rate continues as it has in the past, predict where the graph will be by the year 2000.

The survival rate should be about 70 per 100 or 70% in the year 2000.

3. Assuming that the recovery rate continues as it has in the past, predict the year in which cancer will be eliminated.

Assuming that the recovery rate continues as it has in the past, the year in which cancer will be eliminated will probably occur about 2050 if it took about 75 years to reach a 50% survival rate by 1975 from 1900. An additional 50% survival rate should occur in 2050 ($1975 + 75 = 2050$).

4. Compare the shape of the normal cells to the abnormal cells. Describe the differences between the two.

Normal cells have a regular shape, no spaces, and similar shapes. Abnormal cells have an irregular shape, spaces between cells, and a variety of shapes.

5. What are the dark circles in the centre of each cell?

The dark circles are nuclei.

6. Why does the mass of abnormal body tissue cause health problems?

The mass of abnormal body tissue does not perform useful body functions and crowds out the useful body tissue. Thus, normal body functions are impaired or completely destroyed.

7. Write the cancer in order of occurrence, starting with the most common first.

- a. most frequent cancer in males

The most frequent and common cancers in males include the following:

- lung
- prostate
- colon and rectum
- lymphoma
- bladder
- oral
- kidney

- b. most frequent cancer in females

The most frequent and common cancers in females include the following:

- breast
- colon and rectum
- lung
- uterine (body of uterus)
- lymphoma
- ovary
- melanoma

8. Name three forms of cancer that do not occur in both men and women.

Cancers that men and women do not both have include cervix, prostate, and uterine cancer.

9. Compare the frequency of death to the frequency of occurrence. Name three forms of cancer that result in the lowest mortality rate.

Cancers that have the lowest mortality rate include melanoma, mouth, cervix, and bladder.

10. Which form of cancer do you think is caused, at least partially, by tobacco use?

Mouth cancer is partially caused by tobacco use such as pipe smoking, tobacco chewing, and cigarette and cigar smoking.

11. What is the most deadly form of cancer?

The most deadly forms of cancer are breast and lung cancer.

12. What form of cancer is caused by suntanning?

Skin cancer is caused by suntanning.

13. Since people cannot avoid outdoor activities or live away from the sun, they must learn to live with it sensibly. What precautions can you take to reduce exposure to ultraviolet radiation and the risk of developing skin cancer during participation in outdoor activities?

The use of sunscreen and clothing protection is now highly recommended by medical authorities to reduce exposure to ultraviolet radiation and the risk of developing skin cancer from participation in outdoor activities.

14. Why does a dental technician cover your chest with a lead apron when you have dental X-rays taken?

Your chest is covered with a lead apron when you have dental X-rays taken to prevent damage or destruction of healthy cells from background radiation.

15. Radiation from radioactive cobalt-60 is used to treat cancer. What does radiation suggest in terms of living cells?

Radiation can destroy living cells.

16. Name three things that you should do if there is a history of cancer in your family.

Three things that you should do if there is a history of cancer in your family are learn the signs of cancer, have regular checkups, and avoid substances and activities which are known to increase the risk of cancer.

17. How many known carcinogenic substances can you list?

Tobacco products are classed as carcinogens. Many food preservatives, industrial products, and regular household chemicals are known carcinogens.

18. Why is it a good idea to include fresh fruit and other sources of fibre in your diet?

It is a good idea to include sources of fibre in your diet to reduce the risk of intestinal cancer.

19. Name some foods that are high in natural fibres or not highly refined.

Foods that are not highly refined include raw fruit, vegetables, bran, cooked cereals, and dried fruit.

20. If smoking has been shown to cause so many cases of lung cancer, why do people still smoke?

Tobacco is an addictive substance. The addiction is so strong that even though people have a good chance of getting cancer, they use tobacco regardless of the danger. Some people have very strong willpower and are able to quit smoking or chewing tobacco. Others need the help of chemicals and counselling.

21. Second-hand smoke has been shown to be dangerous, especially for children and people with other health problems. Why then do people tolerate smoking in public places or in places where there are children?

Smoking used to be completely acceptable everywhere: at home, at work, and on television. Times have changed but old habits and customs die hard. Tobacco is still a large industry, and there are millions of people who smoke. As fewer people take up the habit, the chances of being exposed to secondhand smoke decrease.

22. Explain why a doctor would have to cut away surrounding tissue to remove a malignant tumor.

Malignant cancer spreads to the rest of the body. Removing nearby tissue removes any cancer cells which may have separated from the tumor and results in a higher chance of success.

23. What are the disadvantages of using chemotherapy?

One side-effect of using chemotherapy is the loss of hair during therapy.

Section 3: Activity 3

1. What are three common symptoms of diabetes?

The three common symptoms of diabetes are loss of weight, thirst, and frequent urination.

2. Who discovered insulin?

Dr. Banting and Dr. Best discovered insulin.

3. Where is insulin produced?

Insulin is produced in the pancreas.

4. Why do you think Type I diabetes is called juvenile-onset diabetes?

Type I diabetes is called juvenile-onset diabetes because it starts in young people (under the age of 25).

5. Is there anything in a person's lifestyle that could cause the development of diabetes?

Type I diabetes seems to have no relation to life style. Type II diabetes seems to be related to age (over 40) and being overweight.

6. What are the two types of diabetes?

The two types of diabetes are Type I, or juvenile-onset diabetes, and Type II.

7. What is the difference between the two types of diabetes?

In Type I diabetes, insulin-producing cells are destroyed, whereas in Type II the body does not use the insulin it produces.

8. Which group of people are more susceptible to Type I diabetes?

The group of people that are more susceptible to Type I diabetes are usually people under 25 years of age who have a thin stature.

9. Which type of diabetes can be controlled by following a prescribed diet?

Type II diabetes can be controlled by following a prescribed diet.

10. Name five complications that could result from having diabetes.

Five complications that could result from having diabetes are blindness, strokes, heart attacks, kidney problems, and nervous conditions.

Section 3: Follow-up Activities

Extra Help

1. In this section you have studied three non-communicable diseases. Name the three that you have studied.

The three diseases studied include heart disease, cancer, and diabetes.

2. Smoking is a major cause of heart disease and cancer.

- a. Name the two kinds of heart disease studied in this section.

The two kinds of heart disease studied include heart attack and stroke.

- b. Define these two diseases.

A heart attack occurs when there is a blockage of blood flow to the heart. A stroke occurs when there is a blockage of blood flow to the brain.

3. Cancer is a word that describes many diseases. How do you decide which cancer is meant?

Each cancer is named by the body part that is affected.

4. Answer the following true and false questions. Place a T in the blank if the statement is true and an F in the blank if the statement is false.

 T a. Heart disease is the number one cause of death in Canada.

 F b. Exercise puts strain on your heart and weakens it.

Proper exercise strengthens your heart muscle.

 F c. Diabetes is caused by a lack of insulin.

Type I is caused by a lack of insulin. Type II is caused by an inability to use the insulin properly.

 F d. It is healthy to consume a great quantity of animal fat.

Animal fat is saturated fat and probably contributes to high cholesterol.

 T e. Communicable diseases can be contagious.

 T f. Atherosclerosis is a blocking of blood vessels.

 F g. Skin cancer is almost always deadly.

Skin cancer can almost always be cured by surgery.

 F h. Cigarette smoke causes cancer on contact.

The mechanism is unknown but results show that continued exposure to cigarette smoke results in an increased rate of lung cancer and emphysema.

F i. Diabetes is a communicable disease.

Diabetes is noncommunicable.

 F j. Juvenile-onset diabetes rarely needs insulin.

Juvenile-onset diabetes always requires insulin.

 F k. Benign tumors are harmless.

Benign tumors can be dangerous. The tumor or its cells do not travel to other body organs but the growth of the tumor can cause the organs to be adversely affected.

 T l. Metastasis is the spread of cancer from one place to another.

Enrichment

1. Canadian medicine and hospital care is beginning to suffer because of very high costs. A heart transplant can cost more than \$500 000. Should society demand that only those who can afford heart transplants receive them?

Solutions to these problems are often both complex and laced with moral judgements.

Here are some of the ideas that you may have discussed.

- *Heart transplants are risky and while the success rate is increasing, the number of years of life one receives with a new heart is still very low. You could argue that the money would be better spent in other areas.*
- *Someone has to donate the heart (or other organs) for transplant. There have been transplants from animals (such as baboons) to people. If animals can be exploited for their organs, can it be very far away before people are being exploited for their organs where the wealthy purchase the organs of the poor?*
- *As transplants become more common, the cost of performing the operations may decrease to the point where it is reasonable for all citizens to have access to transplants and not bankrupt the medical system.*

2. Lifestyle is sometimes blamed for certain diseases. Obesity and diabetes, smoking and lung cancer, lack of exercise and heart disease are just a few of these relationships. Should people who contribute to a disease by their lifestyle be required to pay their own medical costs for the treatment of these diseases?

Solutions to this problem are complex and varied.

- *You can argue that some of the disorders are very hard for people to overcome. For example some people are overweight because heredity plays a large part; some people cannot exercise enough because of other health problems. It would be unfair to penalize them since the line between self infliction and misfortune is so vague it would be best to treat all people equally and let everyone have equal access to medical care.*
- *You could argue that it is only fair to have people pay for their lifestyle choice. This concept is used in many other areas. For example, if you want a larger life insurance policy, you can buy it. If you don't want any life insurance, you can do without. If you want to insure your valuables against theft, you can pay for the insurance yourself.*

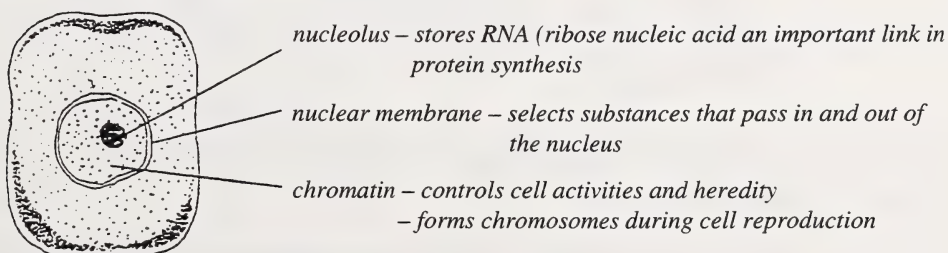
If you want to have your medical costs covered, you have to show that you did not contribute to the disease. If you did contribute to the disease (say you have lung cancer and you smoke), then you have to pay the medical costs yourself.

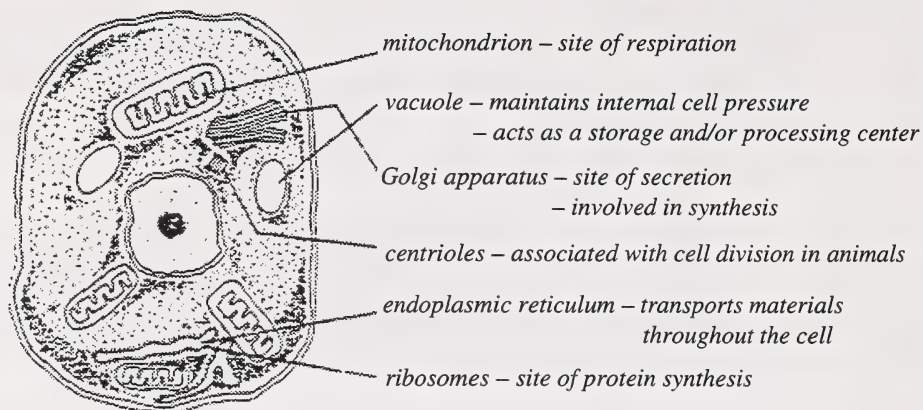
Key to the Assignment Booklet

Section 1 Assignment (24 marks)

- (5 marks) 1. a. Draw a typical cell and label six important cell parts or organelles.
- b. Outline the function of the cell parts which you identified in your diagram.

Answers may vary but typically could include the following.





- (2 marks) 2. What are four common characteristics of all living things?

All living things require water and nourishment, and they grow and reproduce.

- (2 marks) 3. Describe the difference between a plant and animal cell.

Plant cells are surrounded by a solid cell wall and animal cells have a membrane which keeps the cell contents together and allows substances to pass into and out from the cell.

- (3 marks) 4. State the function of the following cell parts.

- a. a cell nucleus

A nucleus directs all cell activities and determines its hereditary characteristics.

- b. cytoplasm

The cytoplasm is a complex jelly-like transparent substance surrounding the nucleus. It contains a number of organelles which perform specific cell functions.

- c. cell membrane

A cell membrane or outer cover keeps the cell contents together much like a container.

- (1 mark) 5. What is protoplasm?

Protoplasm is not a separate or specific substance but the living contents of a cell, composed of the nucleus and cytoplasm.

(3 marks) 6. Describe chromosomes in terms of the following.

- a. their structure or composition

Chromosomes are strands or threadlike structures made from DNA wound like a spiral ladder around a protein core.

- b. how they reproduce

Chromosomes reproduce by mitosis and meiosis.

- c. their function

Chromosomes determine the genetic code or hereditary traits for organisms.

(4 marks) 7. What is the difference between mitosis and meiosis in terms of the following?

- a. chromosomes during cell division

During mitosis the chromosome number is the same as that of the parent cell. During meiosis, the chromosome number is one-half that of the parent cell.

- b. their intended purpose

Mitosis maintains continued growth and repair of cells, whereas meiosis produces male and female reproductive cells.

(2 marks) 8. If your father's eyes are brown, your mother's eyes are blue, and your eyes are brown, what conclusion can you make about the genetic trait of eye colour?

Brown eye colour is the dominant trait and blue eyes are the recessive trait.

(2 marks) 9. What are some known diseases that are inherited?

Duchenne's muscular dystrophy and Down's syndrome are examples of inherited diseases.

Section 2 Assignment (32 marks)

(2 marks) 1. The organism that causes bubonic plague is a *Bacillus*. What two things does the name *Bacillus* suggest?

*The name indicates that the *Bacillus* is a bacterium and is rod-shaped.*

(4 marks) 2. Describe two differences between viruses and bacteria.

Viruses do not have a nucleus which bacteria have, they are about 100 times smaller than bacteria, and they cannot live without living on cells whereas bacteria can live alone.

(4 marks) 3. You performed an investigation in this section in which you allowed bread to become mouldy.

- a. Why did you leave the piece of bread exposed to the air?

The bread was exposed to air so that invisible spores of bread mould had a chance to settle on the bread.

- b. What natural function does the fungus perform?

The natural function performed by a fungus is decay.

- c. What did this investigation tell you about the nature of fungus in terms of size, origin, and rate of growth?

Some fungal organisms such as mould start from very small particles (invisible to the naked eye) found in the environment and grow very rapidly.

(4 marks) 4. Assume that a flu virus is epidemic in your school or place of work. List four methods of disease transmission, and use common or realistic situations to describe the ways in which you could get the flu.

You could contract the disease by

- *contact infection, such as when you shake hands with someone who has the flu*
- *droplet infection, such as when you sit next to someone who coughs or sneezes*
- *waterborne infection, such as when you share a drink or food with someone who has the disease*
- *foodborne infection, such as when you eat food that has been improperly handled by an infected person in the cafeteria*

(7 marks) 5. a. List the diseases that are communicable.

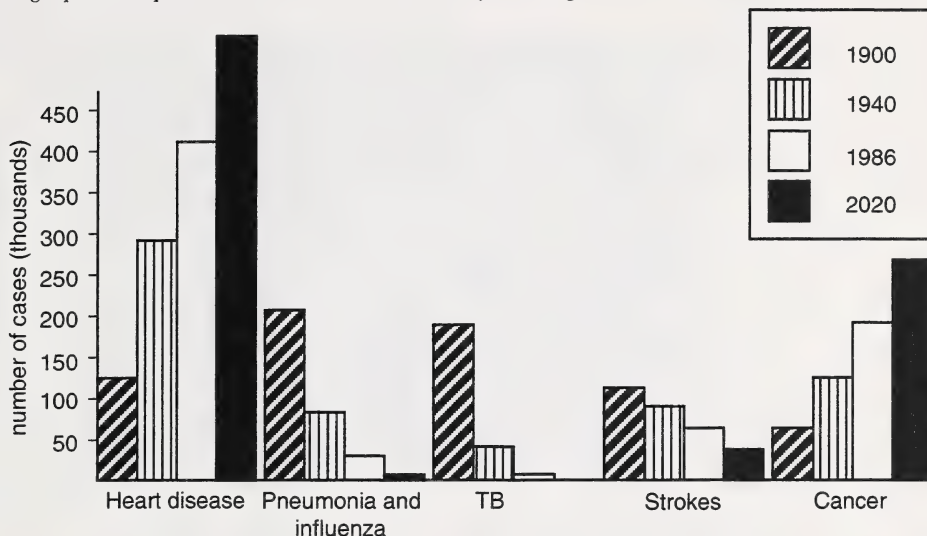
Communicable diseases are pneumonia, influenza, and TB.

- b. If a fourth bar were drawn for the year 2020, predict whether the height of the bar for each disease would go up, down, or remain the same.

The fourth bar should be at a height of about

- *500+ for heart disease (up)*
- *half the 1986 bar for pneumonia and influenza (down)*
- *barely existent for TB (down)*
- *50 for strokes (down)*
- *between 250 and 300 for cancer (up)*

A graphical representation would look like the following:



- (4 marks) 6. Assume that you are a medical doctor living on a remote island where a communicable disease strikes several people on the island. Describe two things that you do to help stop the spread of the disease.

You could try to determine how the disease was spread by investigating the activities and behaviour of the sick people over the past few days or weeks. You could isolate the sick people from the healthy in the hope that the disease is spread directly from the sick to the healthy. As a doctor you could look for the organisms of transmission such as virus, bacteria, protist, fungus, or insect. You could look for the mode of transmission such as waterborne, airborne, contact, foodborne, or insect borne.

- (1 mark) 7. What structure of viruses makes the virus dependent on other cells?

Viruses lack a nucleus.

- (1 mark) 8. What is one beneficial use of bacteria?

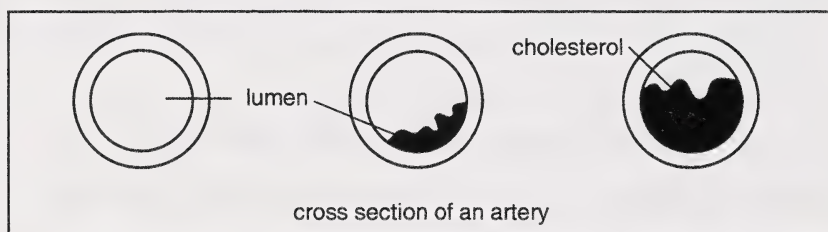
Bacteria is used in producing products such as cheese, yogurt, and wine.

(5 marks) 9. In the space provided on the response page, write the term that best matches each definition.

- | | |
|------------------------------------|--------------------|
| a. a type of viral disease | <i>mumps</i> |
| b. another name for bubonic plague | <i>black death</i> |
| c. carrier of plague | <i>rat</i> |
| d. magnifies | <i>microscope</i> |
| e. coccus | <i>sphere</i> |
| f. structure of a virus | <i>crystal</i> |
| g. spiral bacteria | <i>spirillum</i> |
| h. plant-like organism | <i>fungus</i> |
| i. sexually transmitted disease | <i>STD</i> |
| j. cause of strep throat | <i>bacterium</i> |

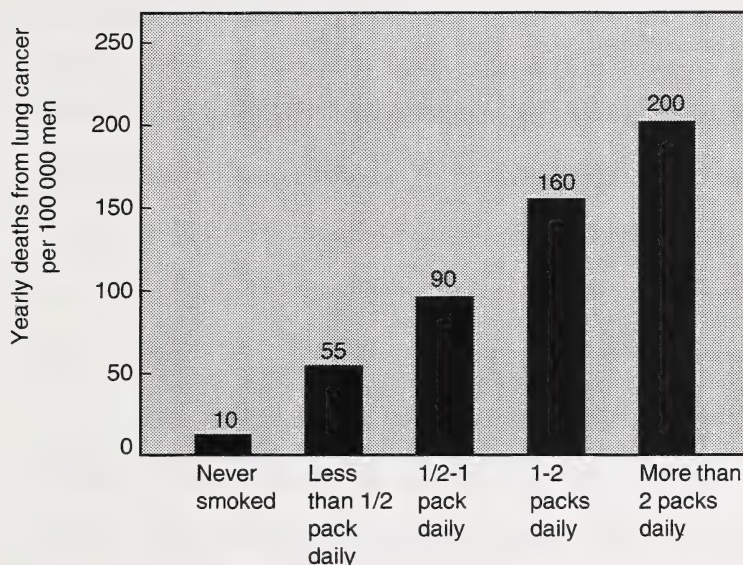
Section 3 Assignment (44 marks)

- (4 marks) 1. Study the following diagrams. If your blood vessel was like the second one, what four things could you change in your lifestyle to prevent atherosclerosis?



To prevent atherosclerosis the four lifestyle changes that would need to be made are to quit smoking, check with your doctor to begin a suitable diet, develop a good exercise program, and bring down body weight to the recommended level.

(3 marks) 2. Study the following graph to answer the questions that follow.



- a. Describe what happens to the death rate as the quantity of cigarettes smoked increases.

As the amount of cigarettes smoked increases, the risk of developing cancer increases.

- b. Compare the deaths caused by lung cancer for the non-smoker versus the deaths caused by lung cancer for the person who smokes more than two packs a day. Approximately how many times does the risk of death increase?

A person who smokes compared to one who does not increases the risk by a ratio of 20:1 or a factor of 16.75 times greater.

(6 marks) 3. a. If you have frequent and painful urination, what else could this indicate besides possible cancer?

Frequent and painful urination could be caused by infections, STDs, or diabetes.

- b. Where could lumps that are cancerous grow on your body?

Cancerous lumps can grow on any part of the body. Special care should be given to warts, moles, and unusual lumps. Watch for increased growth of moles or colour changes in them. Report any new lumps to your doctor.

- c. If you spit up blood when you cough, do you have cancer?

Spitting up blood could indicate cancer but it could also be due to TB, smoking irritation, nosebleed, or throat injury.

- (3 marks) 4. What six symptoms could indicate that you might have cancer?

Symptoms of possible cancer could include

- *change in bladder or bowel habits*
- *a sore that does not heal*
- *unusual bleeding or discharge*
- *thickening or lump in breast or elsewhere*
- *indigestion or difficulty in swallowing*
- *obvious change in a mole or wart*
- *nagging cough or hoarseness*

- (2 marks) 5. If you have a sore that does not heal what two diseases could account for this?

A sore that does not heal could be caused by cancer or diabetes.

- (2 marks) 6. What are two possible indications of lung cancer?

Two possible indications of lung cancer could include coughing up blood, constant hoarseness, and nagging cough.

- (4 marks) 7. a. List the forms of cancer that you have some ability to prevent.

Some cancers that a person has some ability to prevent are lung, bladder, mouth and larynx, and skin cancer.

- b. List the forms of cancer that are more difficult to prevent.

Some cancers that a person has difficulty to prevent are leukemia, prostate, colon or rectal, breast, uterine, and cervical cancer.

- (9 marks) 8. Name one habit or activity you can avoid to reduce the risk of contracting each type of cancer listed in the table.

lung cancer	<i>smoking</i>
bladder cancer	<i>smoking; using caution when working with chemical dyes</i>
mouth and larynx cancer	<i>smoking</i>
skin cancer	<i>sunbathing; irritating moles and warts</i>
leukemia	<i>avoiding radiation</i>
prostate cancer	<i>reducing alcohol consumption</i>
colon or rectal cancer	<i>having regular check-ups, avoiding eating refined foods</i>
breast cancer	<i>having regular check-ups</i>
cervical or uterine cancer	<i>having children, losing weight, lowering blood pressure</i>

- (1 mark) 9. What precautions should you take if there is a history of cancer in your family?

If there is a family history of cancer you should do the following:

- *have regular medical check-ups*
- *learn the danger signals of cancer*
- *avoid carcinogens (e.g., stop smoking)*

- (2 marks) 10. Describe the two symptoms of skin cancer.

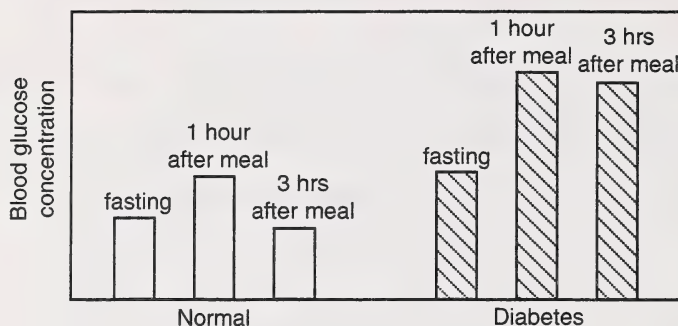
Two symptoms of skin cancer are a sore that does not heal and an abnormal growth in a wart or mole.

- (4 marks) 11. What are four common symptoms of diabetes?

Common symptoms of diabetes are the following:

- *loss of weight*
- *unquenchable thirst*
- *ravenous hunger*
- *frequent urination*

- (2 marks) 12. Study the following graph. It shows the amount of glucose in the blood of a normal person and a diabetic person. Explain the difference in the chart at three hours after the meal.



Three hours after the meal, the normal person's blood sugar is reduced because insulin caused the cells to absorb the blood sugar. The diabetic has no insulin, so sugar is not removed from the blood.

- (2 marks) 13. Study the information in the following table. On the basis of this chart, why would you believe that cancer and diabetes can be partly inherited?

Disease	Identical twins	Fraternal twins
site of cancer (when both have cancer)	95%	58%
diabetes	84%	37%
cancer	61%	44%

The identical twins have a higher match for both diseases than the fraternal twins; therefore it is likely that the cancer or diabetes was inherited.

SCIENCE 24

Module 4: Disease Defenses

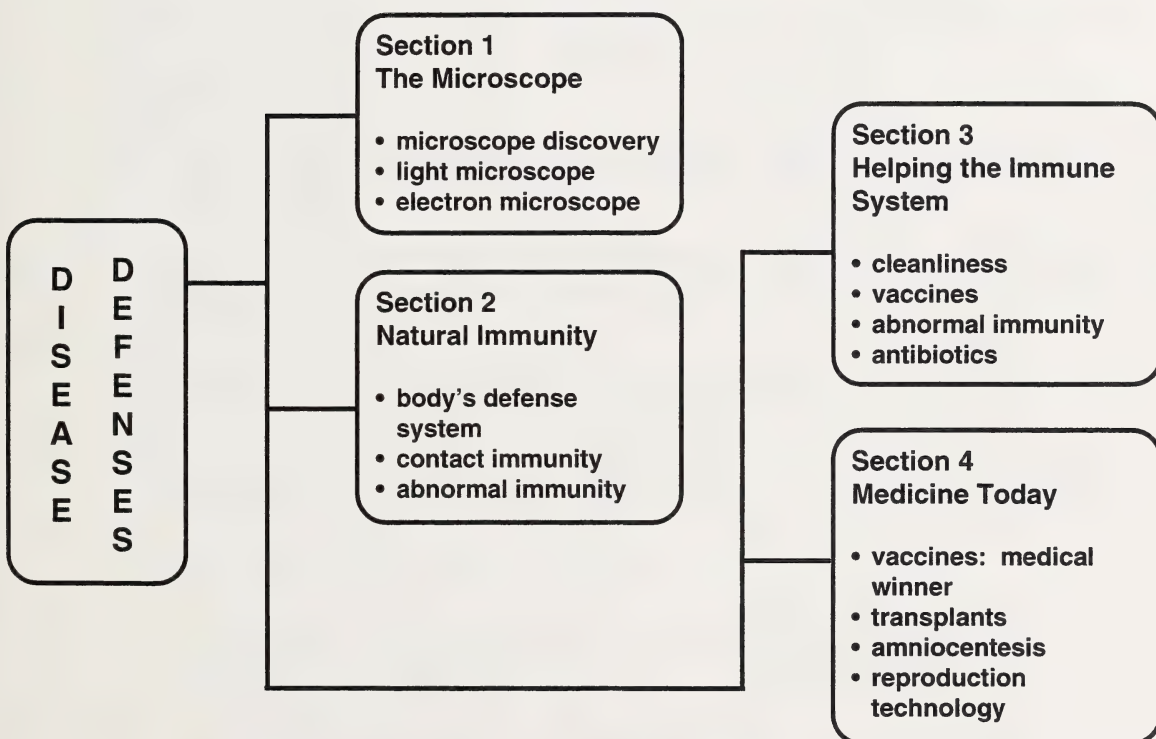


Learning Facilitator's Manual

Module 4: Disease Defenses – Overview

The emphasis in this module is on communicable diseases and the body's defence system against them. This includes the natural and acquired systems of immunity that the human body has developed in its fight against disease.

Biotechnical and biomedical processes that have greatly enhanced the human immune systems are also considered. As such, the development and dependence on antibiotics and vaccines are examined. The role of the microscope as an essential tool for looking at microbes and cells forms an important component in identifying disease-causing microorganisms.



Materials You Need

The following is a list of materials necessary to complete the investigations and activities in Module 4.

Section 1: Activity 2

Part A

- compound microscope
- prepared slides
- microscope slides and cover slips
- eye dropper
- tweezers
- scissors
- sample specimens which could include
 - hair
 - piece of fingernail
 - newspaper
 - tissue paper
 - cloth
 - pond water
 - onion
 - plant leaves

Part B

- microslide viewer
- prepared slide set 58 which includes
 - cork (300×)
 - onion skin (200×)
 - green leaf (300×)
 - cheek cells (900×)
 - blood cells (900×)
 - nerve cells (300×)
 - bacteria (1500×)
 - virus (50 000×)

Suggested Enrichment Activities

The following activities could be done to enhance the module.

- Invite the school nurse or a health unit nurse to discuss specific diseases such as AIDS, meningitis, etc., or the immunization program.
- Go on a field trip to the University of Alberta Zoology Department for electron microscopy.

Evaluation

The evaluation of this module will be based on four assignments:

Section 1 Assignment	20 marks
Section 2 Assignment	30 marks
Section 3 Assignment	32 marks
Section 4 Assignment	<u>18 marks</u>

TOTAL	100 marks
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Section 1: The Microscope

This section deals with the discovery and types of microscopes. It also discusses the existence of an unseen microscopic world.

Section 1: Activity 1

1. Why did van Leeuwenhoek select the term *animalcule* for the microscopic organisms which he observed in a drop of water?

Leeuwenhoek probably selected the term animalcule for the microscopic organisms which he observed in a drop of water because they were invisible to the naked eye but moved around like land animals.

2. Years later when Louis Pasteur, a French scientist, suggested that little animals in wine caused it to go sour, his idea was highly ridiculed and laughed at. Why?

When Louis Pasteur suggested that little animals in wine caused the wine to go sour, his idea was highly ridiculed and laughed at because these little animals were not visible to the naked eye.

3. Suggest three uses modern medicine has for the microscope.

Answers may vary, but three uses for the microscope by modern medicine could include identifying disease-causing microorganisms, identifying cancer cells, and performing microsurgery under magnification.

4. Give three medical technologies that did not exist in 1950.

Answers may vary, but medical technologies that did not exist in 1950 could include open-heart surgery, organ transplants, microchip-driven artificial limbs, diagnostic use of scanners and computers, laser surgery, test tube babies, mechanical organs, and genetic testing. Some of these technologies were developed very recently.

5. What does this tell you about the growth of knowledge?

The growth of knowledge shows that learning something based on existing knowledge or on something that has already been discovered is easier to understand than learning about it for the first time.

6. How did the discovery of the microscope advance the understanding of disease organisms?

The discovery of the microscope increased the understanding of disease organisms by enabling scientists to see, identify, and discover the properties of these microscopic organisms.

7. How did the discovery of mouth bacteria lead to a change in people's personal hygiene?

The discovery of mouth bacteria changed people's personal hygiene practices through regular brushing, flossing, and cleaning.

8. Suggest three common places where disease-causing bacteria may be found.

Answers may vary, but common places where disease-causing bacteria may be found include uncooked food, food leftovers, food containers and preparation surfaces, kitchen sinks, floors, counter tops, tables, garbage containers, barnyards, and skin.

9. Suggest three ways in which disease-causing bacteria is brought under control.

Answers may vary, but ways in which disease-causing bacteria is brought under control include washing of hands and food preparation surfaces, using heat to cook food, refrigeration of food and food leftovers, and practising general hygiene.

10. Van Leeuwenhoek was a Dutch merchant whose hobby was to grind lenses. Although he was not a trained scientist, why is he considered one now?

Van Leeuwenhoek is considered a scientist because of his many observations and his careful recording of data and methods used in his investigation of specimens.

Section 1: Activity 2

1. Select the labelled parts of the compound microscope to identify the following functions:

- | | |
|---|--------------------------|
| a. reflects light through specimen | <u>mirror</u> |
| b. adjusts the light | <u>diaphragm</u> |
| c. sharpens image by slight movement of stage | <u>fine adjustment</u> |
| d. connects eyepiece and objective lens | <u>body tube</u> |
| e. raises and lowers stage for focussing | <u>coarse adjustment</u> |

f. dims the light	<u>iris diaphragm</u>
g. supports slide or specimen	<u>stage</u>
h. supports the microscope	<u>base</u>
i. allows microscope to be carried	<u>arm</u>
j. changes magnification	<u>objective</u>

2. Using a magnifying glass, look at the letter “a” in this sentence with the glass. About how many times does it magnify the letter?

The letter “a” should be magnified about four times under a magnifying lens.

3. A light microscope can magnify up to 1000 times. How tall would you be if you were magnified 1000 times?

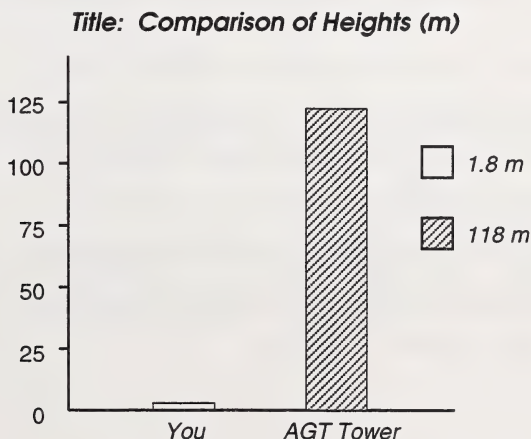
Answers may vary, but if you were 180 cm tall you would be 1800 m or 1.8 km tall if you were magnified 1000 times.

4. The viewing gallery in the AGT tower in Edmonton is 118 m tall. How many times taller would you be than the AGT tower if you were magnified 1000 times?

Answers may vary, but if you were 180 m tall when you were magnified 1000 times, you would be $1800/118 = 15$ times taller than the AGT tower.

5. Draw a bar graph to compare your actual size with that of the AGT tower.

Answers may vary, but if you were 180 cm (1.80 m) tall, the bar graph for the AGT tower compared to your actual size would be about 66 times higher ($118/1.8$). Your graph should be similar to the following.



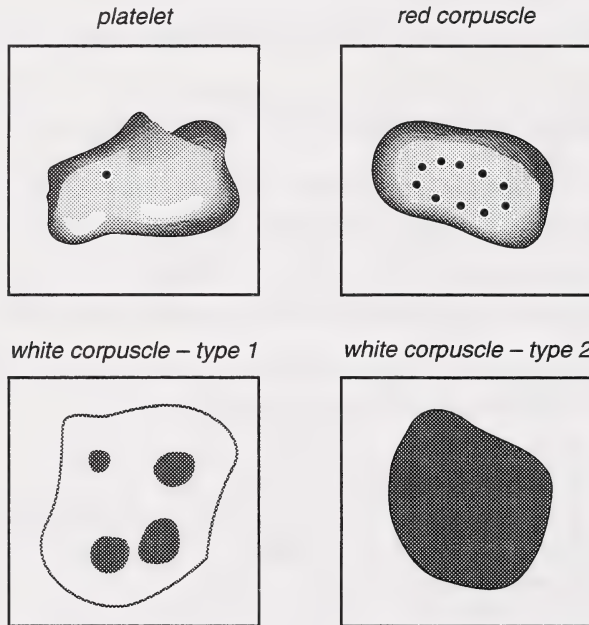
Questions 6 and 7 are based on the following investigation:

Investigation: Observing Prepared Slides

In this investigation you will use prepared slides or prepare your own slides and view them through a compound microscope. You will sketch the specimens you observe.

Make a sketch of what you saw.

Your sketches should represent the components from a human blood smear which you viewed through a microscope or microslide viewer similar to the following outline sketches.



6. Why were you asked to make careful sketches of your specimen?

A sketch is a permanent record of your observations, and it can be used as evidence. The more important concept is that in order to make a detailed sketch, you have to be much more observant than you are normally.

7. Suggest a reason why scientists make detailed sketches of what they observe under a microscope.

To keep a record and to be able to show others their observations, scientists must make careful observations and detailed sketches.

8. Scientists in modern laboratories don't make sketches of microscope views. How do they record their observations of views through a microscope?

Modern scientists take photographs of what they are viewing. By doing this, they get a quick, precise record of what they are viewing.

9. Microscopes are a very useful scientific tool, especially in medicine. Do you think a microscope is usually used to determine what disease a patient might have? Explain your answer.

Only in very unusual circumstances are microscopes used to determine a patient's disease. It is very difficult to identify a particular bacterium or virus as being a problem from only viewing a sample. There may be hundreds of foreign bodies in a single sample of human blood or tissue. Specific chemical tests, growth media, and technical analysis prove more accurate and reliable for determining which disease is at work.

10. a. While a light microscope makes things appear much larger, there are a number of difficulties in its use. One difficulty is in obtaining proper specimens to view. Where would you get a live specimen of a paramecium?

You could find specimens in pond water or possibly in stagnant water. Obtaining these samples in winter time is very difficult. You may be able to order specimens from a scientific catalogue.

- b. Why is it difficult to observe live specimens under a microscope?

Live microorganisms move very quickly, and you usually need a chemical to slow them down enough to be able to view them for a reasonable length of time.

Often small organisms have clear bodies and must be stained in order to see them. The staining often kills the organism.

11. Prepared slides offer some distinct advantages over homemade slides. Why is this?

Prepared slides offer these advantages:

- *A large number of very good quality slides can be made when an optimum set of specimen is collected.*
- *Highly trained professionals can stain and produce excellent quality slides.*
- *Certain specimens (bone, muscle, and other normally opaque substances) must be shaved into very thin slices by a special machine before they can be mounted into slides.*

Section 1: Activity 3

1. Suggest why an electron microscope would likely be found in a large hospital.

An electron microscope would likely be found in a large hospital for examination of viruses, tissue, and blood samples taken from patients.

2. Suggest why an electron microscope would likely not be found in a high school.

An electron microscope would not likely be found in a high school due to its size, its high cost, and the training required in using it.

3. Describe two main differences between a light microscope and an electron microscope.

A light microscope uses light and lenses, while an electron microscope uses an electron beam and electromagnets. An electron microscope can magnify 200 times or more than a light microscope can. Live specimens cannot be viewed with an electron microscope.

4. What system is used to focus light in the light microscope?

The light microscope uses lenses to focus light.

5. What system is used to focus electrons in the electron microscope?

The electron microscope uses electromagnets to focus a beam of electrons.

6. What is the energy source in the electron microscope?

Electrons provide the energy source in the electron microscope.

7. How is the image received in the electron microscope?

The image in the electron microscope is often received on a view plate or large screen similar to a TV screen.

8. How is the image received in the light microscope?

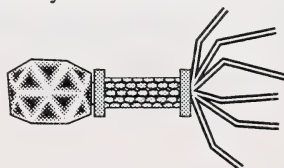
The image in the light microscope is received through the eyepiece lens.

9. Measure the length of the following virus in millimetres, and divide this number by the magnification to obtain the actual size of the virus. Show your calculations.

Bacteriophage (40 000×)

$$\frac{45 \text{ mm}}{40\,000} = 0.001125 \text{ mm}$$

The actual length of the virus is 0.001125 mm.



10. What is meant by resolution?

Resolution refers to the clarity of an image. It is the production of an image under magnification in which details are clearly visible.

Section 1: Follow-up Activities

Extra Help

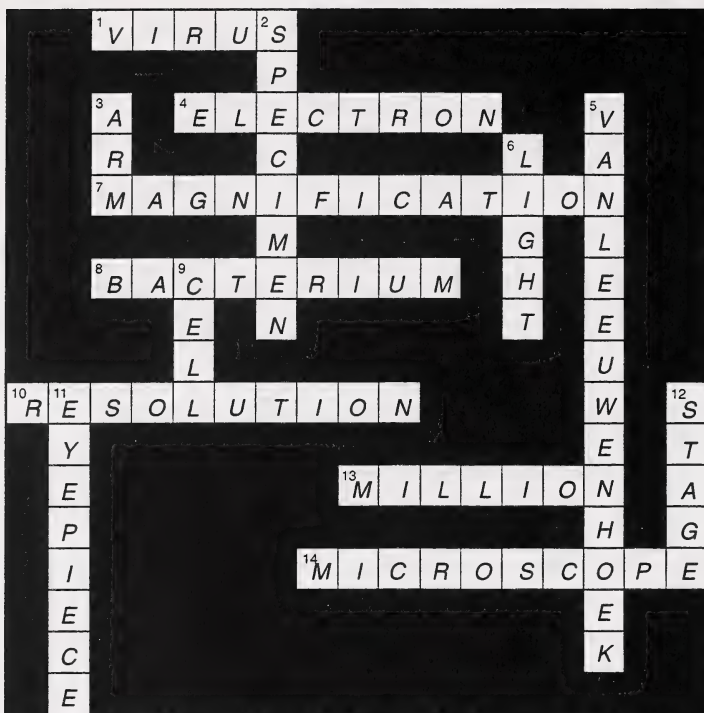
Do the following crossword.

Across

1. unseen organism that can only be seen using a light microscope
4. one type of microscope
7. another word for enlargement
8. a type of micro-organism
10. clarity in a microscope image
13. number of times an electron microscope magnifies
14. an instrument that enlarges objects

Down

2. what is put on the slide
3. the part of the microscope that you can hold on to for carrying it
5. the man who improved the microscope
6. another type of microscope
9. smallest unit of an organism
11. part of the microscope that you look through
12. what specimens are mounted on



Enrichment

1. Research and write a report on Anton van Leeuwenhoek.

Your answer will vary, but it could include some of the following facts about Leeuwenhoek:

- was a skilled lens grinder
- made lenses about half the diameter of a pea
- made microscopes that magnified 270 times
- was the forerunner in study of microorganisms
- studied head of fly, skin, rainwater drop, teeth scrapings, tadpole blood vessels, etc.
- discovered capillaries and one-celled animals which he called beasties or animalcules
- made bacteria drawings; confirmed Malpighi's findings
- exhibited qualities of a scientist by observing, collecting data, and experimenting

2. Research and write a report on the properties that make the electron microscope an improvement over the light microscope limitations.

Your answer will vary, but it could include some of the following features of electron microscopes:

- *uses beam of electrons rather than light*
- *magnifies millions of times*
- *reveals details of small objects clearly*
- *greatly improves resolution of small objects over light microscope*
- *electron beam passes through specimen*
- *image focussed on fluorescent TV screen or photographic plate by magnetic lenses*

3. Research and write a report on known diseases caused by viruses.

Answers will vary, but diseases caused by viruses could include the following:

<i>polio</i>	<i>flu</i>	<i>rabies</i>	<i>meningitis</i>
<i>yellow fever</i>	<i>cold sore</i>	<i>shingles</i>	<i>warts</i>
<i>mumps</i>	<i>measles</i>	<i>hepatitis</i>	<i>cold</i>
<i>herpes</i>	<i>malaria</i>	<i>vaccinia</i>	<i>chickenpox</i>
<i>viral pneumonia</i>	<i>viral tumor</i>		

Section 2: Natural Immunity

This section deals with how the body recognizes disease organisms. It also discusses the ways in which the body fights disease. The section deals with allergic reactions.

Section 2: Activity 1

1. Castles were specially built to provide protection and defence from enemy attack. What castle features protected its occupants from invasion?

Some features of a castle that help to protect the castle's occupants from invasion include a moat, fortified structure, few openings, protected entrances, secret passages, and soldiers to defend against attack.

2. Why did castles sometimes fail to offer protection to their occupants?

Castles sometimes failed to offer protection to their occupants due to enemies, a surprise attack, and a shortage of supplies in the event of a prolonged siege.

3. Name as many of these openings as you can think of.

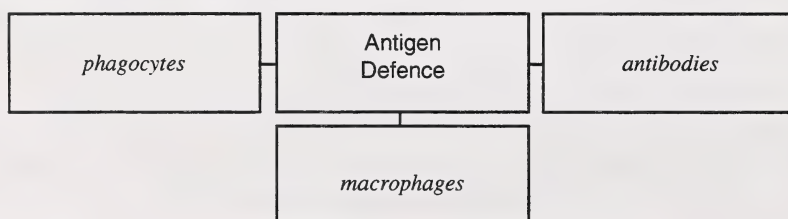
The body openings include ears, eyes, nostrils, mouth, anus, genital openings, and skin pores.

4. All body openings have a special defence system. How are the following entrances into your body guarded?

Body opening defenders include

- nostrils: mucus and hairs*
 - ears: hairs and wax secretions*
 - eyes: tears, eyebrows, eyelashes, and eyelids*
 - skin pores: several layers, hair*
 - mouth: lips, teeth, epithelial lining*
5. Make a list of the external defences that your body has to combat disease.
- External defenses that your body has to combat disease include skin, mucus, hair, and tears.*
6. List four antigens or disease-causing organisms that can enter or invade your body.
- Antigens or disease-causing organisms that can enter or invade your body include viruses, bacteria, yeast, fungus, and protists.*
7. Record the three types of organisms that defend your body against the antigens that enter your body.

Three types of organisms that defend your body against the antigens that enter your body include phagocytes, antibodies, and macrophages.



8. What are the two basic ways in which a phagocyte kills antigens?

Two ways that a phagocyte kills antigens are by devouring the antigen and by adherence.

9. Why do you think that babies who are bottle-fed suffer infections of nose, ear, and throat more often than breast-fed babies do?

Babies who are bottle-fed suffer infections of nose, ear, and throat more often than breast-fed babies do because they lack the mother's antibodies found in her first milk or colostrum.

Section 2: Activity 2

1. What is immunity?

Immunity is a natural resistance to disease.

2. Name two childhood diseases to which you have developed an immunity.

Answers may vary but childhood diseases that you have probably developed an immunity to could include measles, mumps, or chickenpox.

3. What other communicable diseases could you develop an immunity to?

Other communicable diseases that you could develop an immunity to from immunization or direct contact could include smallpox, polio, tetanus, diphtheria, scarlet fever, meningitis, whooping cough, and most other communicable diseases.

4. What other diseases can you get more than once?

Bacterial and fungal infections, influenza, and pneumonia are some diseases that you can get more than once.

Section 2: Activity 3

1. Describe what Kathy's body had done between the first and second exposure to penicillin.

Between the first and second usage of penicillin, Kathy's body had produced antibodies and memory cells to fight against the penicillin.

2. What would likely happen if Kathy took this type of penicillin again?

If Kathy took this type of penicillin again she would likely have a severe allergic reaction to it and could die.

3. Why should Kathy wear a medic alert bracelet?

Kathy should wear a medic alert bracelet so she would not be given penicillin in case she is in an accident, unconscious, or unable to speak.

4. What chemical is responsible for the symptoms of allergies?

The chemicals responsible for the symptoms of allergies are histamines.

5. What kind of medication would you take to counteract allergies?

The medication you would take to counteract allergies is an antihistamine.

6. When is the best time to take this medication?

The best time to take this medication is before you encounter a possible allergy attack.

Section 2: Follow-up Activities

Extra Help

To help you master the concept of natural immunity, match the following terms with their appropriate definitions.

<u>F</u>	1. an opening in your body	A. antigen
<u>H</u>	2. an external defender	B. macrophage
<u>O</u>	3. another name for a white blood cell	C. mumps
<u>D, N</u>	4. a type of antigen	D. virus
<u>A</u>	5. a disease-causing organism	E. smoking
<u>B</u>	6. a large cell that devours antigens	F. mouth
<u>C</u>	7. a communicable disease	G. allergy
<u>D</u>	8. causes the common cold	H. tears
<u>G</u>	9. an abnormal immune system	I. immunity
<u>E</u>	10. weakens your immune system	J. histamine
<u>M</u>	11. an allergen	K. antibody
<u>J</u>	12. a chemical that causes allergic reaction	L. colostrum
<u>I</u>	13. natural resistance to disease	M. pollen
<u>P</u>	14. medication for allergies	N. bacteria

- | | | |
|------------------|-----------------------------------|------------------|
| <u> K </u> | 15. a disease-destroying chemical | O. phagocyte |
| <u> L </u> | 16. a mother's first milk | P. antihistamine |

Enrichment

1. If you or someone you know has allergies, write a paper describing the allergy. Describe the allergens, the allergic reactions, and any methods that help control the allergy.

Answers will vary but the allergy should be described.

- *The allergy could include allergens such as specific foods, cosmetics, drugs, medications, animals, dust, mould, pollen, plants, feathers, wool, and fabrics to name a few common examples.*
- *Allergic reactions may include hives, watery nose and eyes, cold sweat, skin eruptions, wheezing, asthma attack, choking, difficult breathing, heart palpitation, coma, and so on.*
- *Methods used to control allergies may include antihistamine medication, allergy serum injections, or antidotes. Severe attacks may require hospitalization.*

2. Research a childhood disease like mumps, measles, or chickenpox. Describe the symptoms, any mode of prevention, and any secondary effects that could be a problem.

Answers will vary but should include any childhood disease such as mumps, measles, or chickenpox. The known symptoms should be described, as well as methods of prevention and any secondary effects that could be a problem.

The following describes chickenpox:

- *caused by virus entering through nose and throat*
- *spread from person to person through air*
- *2 to 3 week incubation period*
- *starts with mild headache and fever*
- *develops into red rash and ends in bumps*
- *bump appears like a drop of water on a red base*
- *bumps are mainly on upper part of body but can occur anywhere*
- *bumps dry up to form scales or scabs*
- *disease is no longer contagious once the scales form*

Section 3: Helping the Immune System

This section deals with how cleanliness keeps the body healthy. It discusses how vaccines prevent diseases. How chemicals kill disease organisms is discussed. New technologies that will change future medicine is also dealt with.

Section 3: Activity 1

1. What concerns would you have about going to a hospital under these conditions?

Answers may vary, but concerns which you may have about going to a hospital which has unsanitary conditions could include the fear of infection, disease, or unnecessary death.

2. What kind of organisms would be present on the doctor's hands that would cause death?

Disease-causing microorganisms would be present on the doctor's hands that would be transferred to the patient and could cause death.

3. Explain why cleanliness is so important in a modern hospital.

Cleanliness is important in a modern hospital to prevent risk of spreading disease from bacteria and other microorganisms. Large numbers of infected patients and the use of antibiotics over time can produce microorganisms which are resistant to most antibiotics. Infections acquired from hospitals are more difficult to treat than to prevent through cleanliness.

4. If you cut yourself, how should you treat your cut?

If you cut yourself, you should clean your cut with clean water and antiseptic.

5. Explain what diseases IV drug users are more susceptible to from sharing needles. Why?

IV drug users are more susceptible to all diseases because disease organisms can be injected directly into the blood stream. Both communicable and noncommunicable diseases are spread between those who share needles.

6. Suggest why Lister received so much opposition to his method of aseptic surgery.

Lister received so much opposition to his method of aseptic surgery because he replaced accepted standards. The mark of a good surgeon, during Lister's time, was a bloodied apron. Blood was not recognized as a disease-transmitting substance. Microorganisms were not understood or visible.

7. Suggest where aseptic methods are commonly practised in a home. How?

Aseptic methods commonly practised in a home include the use of hot water and germicides to clean walls, floors, toilet bowls, kitchen counters, appliances, cookware, and utensils.

8. Why is Lister considered to be a forerunner in the field of modern surgery?

Lister was considered to be a forerunner in the field of modern surgery because he was the first person to obtain successful results using aseptic surgical methods.

Section 3: Activity 2

1. Were people protected against smallpox by the Chinese method? Why?

The Chinese method could have protected people against smallpox if the skin contained smallpox antibodies, but this was rarely successful.

2. Why do you think they still keep samples of the virus?

Should the smallpox virus still be working somewhere on the planet it is conceivable that another epidemic could occur. The virus is kept to ensure vaccines would be produced and also as a scientific and medical sample. The virus may prove useful in ways not yet foreseen.

3. What is a vaccine?

A vaccine is a substance which stimulates your body to produce the antibodies which are needed to destroy particular disease-causing organisms.

4. Who was the first person to develop a successful vaccine against smallpox?

Edward Jenner developed the smallpox vaccine in 1796. Actually, some other earlier physicians tried vaccinating by using the pus and skin scrapings from smallpox victims. Sometimes this method worked; sometimes it caused the disease. Jenner's vaccine was safe and reliable.

5. Why does the cowpox antibody work against smallpox?

The shape of the cowpox virus and the smallpox virus are so similar that the antibody fits both viruses.

6. What three important steps of the scientific method were followed by Jenner?

Three important steps of the scientific method that were followed by Jenner include

- *recognizing a problem through careful observation*
- *developing an hypothesis*
- *testing the hypothesis*

7. What diseases were you vaccinated for during early childhood in either elementary school or a public health centre?

Answers may vary, but the diseases you were vaccinated for during early childhood could include diphtheria, whooping cough, tetanus, measles, mumps, rubella, and polio.

8. Describe the three methods for preparing vaccine.

Vaccines are prepared by

- *killing the disease organism which can then safely be injected into the body*
- *weakening the disease organism which can then safely be injected into the body*
- *culture a milder form of the disease which can then safely be injected into the body*

9. What does a vaccination accomplish?

A vaccination provides immunity against communicable diseases.

10. What kind of diseases can be controlled by vaccination?

The kinds of diseases that can be controlled by vaccination are some communicable diseases, usually bacterial or viral diseases.

11. What other diseases like smallpox could be eliminated if all people were immunized?

Other diseases that could be eliminated like smallpox if all people were immunized include polio, diphtheria, and measles.

12. What prevents all people from being immunized?

What prevents all people from being immunized includes poverty, ignorance, cost, beliefs, and attitude.

13. What problems could some people develop from being immunized with horse serum?

Some people could develop severe allergic reactions from immunization with horse serum.

14. What diseases have been successfully defeated worldwide?

Smallpox has been successfully defeated worldwide and polio is a close second.

Section 3: Activity 3

1. Explain why penicillin is considered to be a wonder drug.

Penicillin is considered to be a wonder drug because it defeats diseases that at one time killed or maimed vast numbers of people.

2. Why should a person who is allergic to penicillin wear a medical alert bracelet on their wrist?

A person who is allergic to penicillin should wear a medical alert bracelet on their wrist in case of accident or any situation where the person is in an unconscious state and cannot tell medical staff of the allergy.

3. Why should a person continue taking antibiotic medication if they no longer feel any disease symptoms?

A person should continue taking antibiotic medication if they no longer feel any disease symptoms to kill all the disease-causing organisms.

4. Why are stronger doses of antibiotics prescribed over longer periods of time today than a generation ago?

Medical experts have recognized that weak doses of antibiotics over short periods of time were responsible for producing new strains of microorganisms that were resistant to the antibiotics. In order to reduce the chances of this happening, stronger doses of antibiotics are prescribed over longer periods of time in order to completely destroy the microorganism and never give it a chance to produce an antibiotic strain.

5. How could careless use of antibiotics or diluted forms of penicillin prove very costly in the end?

Careless use of antibiotics or diluted antibiotics can prove very costly in the end due to their inability to fight disease.

6. If an antibiotic such as penicillin is not effective against a disease organism, what does this indicate?

If an antibiotic such as penicillin is not effective against a disease, it may indicate that the disease is caused by a virus or that the microorganism is resistant to penicillin.

7. The word *antibiotic* means “against life.” If it destroys or is effective against living disease-causing organisms but not against viruses, does this mean that viruses are non-living? Explain.

Viruses may be non-living material that have a few characteristics of living things.

8. State the four problems associated with the use of antibiotics like penicillin.

Four problems associated with the use of antibiotics are

- *Some people are allergic to certain antibiotics.*
- *Some bacteria become resistant to antibiotics.*
- *Antibiotics do not kill viruses.*
- *Antibiotics also kill some helpful bacteria.*

Section 3: Activity 4

1. Explain what a chromosome is and what it looks like.

A chromosome is a microscopic threadlike structure which carries genes and is found in the nucleus of a cell.

2. What is the total number of chromosomes that you have in the cells of your body?

The total number of chromosomes that you have is forty-six or twenty-three pairs in every body cell except the cells responsible for reproduction, eggs and sperm, which have twenty-three.

3. Explain the function of genes in a chromosome.

The function of genes on a chromosome is to carry hereditary information.

4. In what way is the new chromosome similar to the original during gene splicing?

A chromosome contains many smaller units of genes over its entire length. During gene splicing only a small unit is added to the new chromosome so that most of it is still similar to the original.

5. In what way is the new chromosome different from the original during gene splicing?

The new chromosome is different from the original during gene splicing due to the small unit which has been added to it.

6. Describe how the process of gene splicing could help fight disease.

The process of gene splicing could help fight disease by developing new antibiotics and other natural chemicals that fight disease.

7. What dangers exist in carrying out gene splicing?

A possible danger to the environment, humans, and other animals exists if a previously unknown strain of the bacterium is produced and proved to cause disease. Until a method of control is developed for this strain of bacteria, there could be widespread illness and loss of life.

8. Who discovered insulin?

Insulin was discovered by two Canadians, Dr. Frederick Banting and Dr. Charles Best in 1922.

9. What is the function of insulin in humans?

Insulin is a hormone that regulates the body's ability to use glucose sugar. Many people develop or are born with an inability to use glucose. Insulin, a hormone produced by the pancreas, helps move glucose into cells for use. Lack of insulin in the blood causes glucose to be built up in the blood. It is later excreted in the urine.

10. Insulin is normally made by the human pancreas. When the pancreas is impaired, an outside source must be found. Explain.

Insulin is obtained from the pancreas of oxen, pigs, or sheep. However, scientists developed a bacterium through gene splicing which also produces insulin.

11. Why would some biologists die from microorganisms developed in their laboratory when antibiotics exist?

Microorganisms develop a resistance to antibiotics over a period of time. When antibiotics are no longer effective against microorganisms, some biologists die from exposure to resistant strains of laboratory microorganisms.

12. What two hormones have been produced by gene-splicing bacteria?

Two hormones that have been produced by bacteria with spliced genes are insulin and human growth hormone.

13. What harmful effects could usage of the growth hormone have on a young growing person?

A harmful effect of growth hormone could occur when people use it indiscriminently to become taller.

Section 3: Follow-up Activities

Extra Help

Answer the following true and false questions. Place a T in the blank if the statement is true and an F in the blank if the statement is false. If the statement is false, rewrite it to make it true.

- F 1. Hospitals have always been very clean places.
Hospitals only became clean places in the late 1800s.
- T 2. Aseptic technique involves the use of chemicals that kill microorganisms.
- F 3. Vaccination for smallpox began in England.
Vaccination for smallpox actually began in China and then Turkey before it came to England.
- F 4. Edward Jenner scratched the arm of a small boy with the polio virus.
Edward Jenner scratched the arm of a small boy with cowpox virus; then after the boy had cowpox, he scratched the arm with smallpox.
- T 5. Vaccine can be prepared by weakening disease organisms with chemicals.
- T 6. It is possible to vaccinate against polio.
- F 7. Smallpox is a dreaded disease in the Third World.
Smallpox has been defeated worldwide.
- T 8. Passive immunity is acquired by injecting antibodies.
- F 9. Edward Jenner discovered penicillin.
Alexander Fleming discovered penicillin.
- T 10. Antibiotics kill microorganisms.
- T 11. Antibiotics can cause serious allergic reactions in some people.
- F 12. You should take antibiotics until the symptoms are cleared up. Then you can set them aside.
Antibiotics need to be completely finished as prescribed by your doctor.
- T 13. A unit of length on a chromosome is called a gene.
- F 14. Human insulin can be produced by cloning.
Human insulin is produced by bacteria that have been altered by gene splicing.

Enrichment

1. Research and write a report on insulin.

Answers will vary depending on the availability and use of resources, but they should include some of the following facts about insulin discovery and its functions:

- *discovered by two Canadian doctors, Banting and Best in 1922*
- *first crystalline form prepared by Abel in 1926*
- *produced by islands of Langerhans in the pancreas*
- *prepared or obtained from pancreas of oxen, sheep, and pigs*
- *also prepared by bacteria through gene splicing*
- *regulates body's use of sugar*
- *lack of insulin or its action results in diabetes*
- *insulin injection does not cure diabetes but controls it*
- *scientists don't understand how insulin regulates body sugars*
- *excessive amount of insulin results in hypoglycemia, a condition opposite to diabetes*
- *different types of insulin preparations differ in how long they last, how fast, or how much is needed for injection*

2. Research and write a report on diabetes.

Answers will vary, but they could include some of the following facts about diabetes:

- *The body's blood sugar levels are regulated by insulin produced in the pancreas.*
- *Not enough or reduced sensitivity to insulin can cause diabetes.*
- *Diabetics cannot process normal sugar levels resulting in storage or build up of blood sugars.*
- *Cause of diabetes is unknown but it may be inherited or a virus could trigger it.*
- *Two major types includes juvenile diabetes in children and adult diabetes.*
- *Diabetes ranks among the major causes of death in North America.*

- *Most diabetics are unaware that they have the disease.*
 - *Symptoms of diabetes includes excessive urination and thirst, nausea, vomiting, difficulty in breathing, and loss of weight and strength.*
 - *Complications include blindness, kidney failure, hardening of the arteries, stroke, heart failure, loss of feeling in fingertips and body extremities, and gangrene.*
3. Use your imagination and write a short story on what would happen if you could clone yourself.

Answers will vary, but if you could clone yourself, only your imagination could answer what your expectations would be.

Section 4: Medicine Today

This section deals with the prevention of disease through immunization. It also discusses biomedical and biotechnical processes with transplants, implants, and procedures. The section also deals with reproductive technology.

Section 4: Activity 1

1. Find the highest number of cases and the year in which smallpox, whooping cough, diphtheria, and polio occurred, and organize this data into a table.

The table should have a title and columns of organized data similar to the following:

<i>Year of highest disease incidence during 1900s</i>		
<i>Disease</i>	<i>Year of highest number of cases</i>	<i>Number of cases in thousands</i>
<i>smallpox</i>	<i>1915</i>	<i>57</i>
<i>whooping cough</i>	<i>1922</i>	<i>295</i>
<i>diphtheria</i>	<i>1900</i>	<i>178</i>
<i>polio</i>	<i>1952</i>	<i>55</i>

2. Which disease had the largest number of cases recorded?

The disease recording the largest number of cases was whooping cough in 1922 with 295 000 cases.

3. Which disease recorded the largest number of cases in 1940?

The disease recording the largest number of cases in 1940 was whooping cough with 100 000 cases.

4. Which disease recorded the largest decline in the number of cases from 1920 to 1930?

The disease recording the largest decline in the number of cases from 1920 to 1930 was smallpox.

5. Can you explain why there was a fifty-year decline for the four diseases?

The development of vaccines and worldwide immunization explains why there was a fifty-year decline for the four diseases.

6. According to the graphs, which disease probably does not have a vaccine? Explain.

According to the graphs, the disease which probably does not have a vaccine is cancer since the number of cases is increasing while a decrease has been shown for those diseases that have vaccines.

7. What major factor could explain the decrease in the number of cases for each disease?

One major factor which could explain the decrease in the number of cases for each disease is the existence of vaccines and worldwide immunization against them.

8. Why would you consider diseases to be less life-threatening today than if you were a child during the 1920s?

One reason why you would consider diseases to be less life-threatening today than if you were a child during the 1920s is that vaccines against many of these once life-threatening diseases now exist.

9. Based on the sudden dramatic decrease for the number of cases, estimate the approximate year in which vaccines were introduced for each disease.

The approximate year in which vaccines were introduced resulting in a dramatic decrease in the number of thousands of cases for each disease is estimated to be

- 1920 for smallpox
- 1940 for whooping cough
- 1930 for diphtheria
- 1950 for polio

10. Using the information from the graphs to support your answer, describe the effect of vaccines on disease.

As shown on the graphs, since they were introduced, vaccines dramatically decreased the number of cases of reported diseases.

11. Using the data provided in the graphs, predict what could happen to the four diseases for which there are vaccines?

The data provided in the graphs indicates that the four diseases for which there are vaccines could become extinct.

12. Which of these diseases has been declared no longer active by WHO (World Health Organization)?

The disease which has been declared no longer active by WHO is smallpox.

13. If a disease has been declared to be no longer active by WHO, does it mean that it is no longer a threat? Explain.

Although the smallpox disease has been declared by WHO as no longer active, it does not mean that it is no longer a threat since the microorganism might still exist and could flare up in the future.

14. Where are the record files kept to find out if Matthew needs a tetanus shot?

Record files of previous immunizations are usually kept by the local health unit and family doctor. They could tell if Matthew needs a tetanus shot.

Section 4: Activity 2

1. a. Using the previous illustration, list six body parts which are transplants.

Body parts that are transplants are the following:

- heart
- kidney
- liver
- lung
- cornea
- bone
- blood and blood vessels
- skin

- b. Using the illustration, list six body parts which are implants.

The body parts that are implants include the following:

- hair
- eye lens
- false teeth
- heart valves and pacemaker
- bone joints and plates
- artificial limbs
- fluid drains

2. Suggest a reason why transplanting bone marrow from a youth to an elderly person might prolong life.

Bone marrow produces blood cells. Bone marrow in the elderly may not produce many blood cells compared to the bone marrow from a youth. Healthier blood may prolong life in the elderly.

3. How does your body reject a foreign object, such as a sliver or thorn, that enters your body?

When a foreign object, such as a sliver or thorn, enters your body, your body rejects it by attacking it with white blood cells. The result is a pus-filled site.

4. Why are transplant costs probably much higher today than in 1985?

Transplant costs today are probably much higher than in 1985 due to inflation and improved technology which is costly.

5. The most successful transplant is between people of similar tissue type. What type of people would most likely make the best transplant donors? Why?

The best transplant donors are identical twins or close relatives, since their genetic material is more likely similar to the genetic material type of the recipient.

6. Why would a small blood supply reduce the chance of tissue rejection?

A small blood supply reduces the chance of tissue rejection because antibodies and white blood cells travel in the blood and lymph systems.

7. How would a cataract affect vision?

A cataract reduces vision or produces blindness when the transparent lens becomes opaque due to a cloudy formation.

8. Cornea transplants have been very successful in restoring vision. Why are they not available for all people with vision problems?

Cornea transplants are not available for all people with vision problems as the demand exceeds donors.

9. Why would a prosthesis be periodically replaced even if the parts were not worn out from use?

A prosthesis is periodically replaced as technology constantly improves existing design.

10. Why is a pacemaker called an implant rather than a transplant?

A pacemaker is called an implant rather than a transplant because it is an artificial device which replaces the body part.

11. Could people who have a pacemaker develop problems during strenuous activity? Explain.

A pacemaker is designed to regulate a normal heartbeat between 60 to 70 beats per minute. Strenuous activity increases the heartbeat which would activate the pacemaker to restore a normal heartbeat. Patients with pacemakers engage in moderate rather than strenuous activity to avoid unnecessary problems.

12. What precautions are taken by people with pacemakers?

People with pacemakers avoid exposure to microwaves and other forms of radiation which could cause the device to malfunction.

13. What other body joints have been successfully replaced with a prosthesis?

Other body joints that have been successfully replaced with a prosthesis include knee and elbow joints.

Section 4: Activity 3

1. Can you think of any way to identify and correct the Down's syndrome disease?

The problem could be identified at a very early stage in fetal development but may prove impossible to correct.

2. People with hemophilia can often bleed to death. How could a minor injury or bruise lead to death if there is no evidence of external bleeding?

People with hemophilia can often bleed to death from minor injuries and bruises resulting in internal bleeding which may not be visible externally.

3. Identify one group of people that should consider having amniocentesis done during pregnancy. Why?

Any group of people who have a known family history of inherited disease may consider it wise to have the amniocentesis procedure done.

4. If a person was in a danger group, why would it help to have amniocentesis done during pregnancy?

An amniocentesis done during pregnancy could help to relieve the mother's anxiety if she was in a danger group.

Section 4: Activity 4

1. What is the advantage of removing eggs from a purebred cow and implanting them in an ordinary cow?

An advantage of removing eggs from a purebred cow and implanting them in inferior cows is to produce purebred calves using ordinary cows.

2. Once purebred calves are born from the ordinary cows, how could the breed be further improved?

Once purebred calves are born from ordinary cows, the breed could be further improved by repeating the embryo transplant procedure with the purebred calves once they reach maturity.

3. What problems could result from embryo transplants or gene-splicing technology?

A problem that could result from embryo transplants or gene-splicing technology is the unknown long-range effect or development of other undesired qualities.

4. Why was Louise Brown not really a test tube baby?

Louise Brown is not really a test tube baby as her development occurred in her mother's womb rather than a test tube.

5. Why was the embryo transplant technology referred to as a test tube baby?

The embryo transplant technology was referred to as a test tube baby because of fertilization outside the body, probably in a test tube.

6. How does embryo transplant technology provide hope to some childless couples?

Embryo transplant technology may help some childless couples have children when normal conception fails.

7. How is the HIV virus that causes AIDS spread?

The HIV virus is spread through open sores, sharing of drug needles, blood, and semen.

8. What other measures could reduce the spread of AIDS?

The spread of AIDS could be reduced through avoiding known transmission methods and making decisions on an informed basis.

Section 4: Follow-up Activities

Extra Help

To help you master the concepts in this section, fill in the blanks for the following statements.

1. Vaccines are used to treat **communicable** diseases.
2. Three diseases that vaccines have been developed for are **rabies, rubella, tetanus, polio, diphtheria, smallpox, and whooping cough.**
3. One disease that has been defeated worldwide is **smallpox.**
4. As a child you were also given a test for **tuberculosis.**
5. If you step on a rusty nail you could get **tetanus.**
6. The first heart transplant was performed by **Dr. Christian Bernard.**
7. A **transplant** is the replacement of body parts from one organism to another (usually person to person).
8. When an artificial part of an organ is inserted into a human organ it is called an **implant.**
9. Many times organ transplants encounter the difficulty of **rejection.**
10. One drug used to reduce rejection is **cyclosporin.**
11. A lens implant in the eye cures a disease called **cataracts.**
12. An artificial limb is called a **prosthesis.**
13. The study of cells withdrawn from the fluid around the embryo is called **amniocentesis.**
14. Amniocentesis is good for detecting **inherited** disease.

15. New advances in science allow couples who cannot normally conceive to have babies. This procedure is called an **embryo transplant**.
16. The spread of the virus that causes AIDS can be reduced by using a **condom**.

Enrichment

1. Many people donate their body organs for transplant. Would you be willing to leave your body parts for transplant? Discuss this question in a short paragraph. Give at least three reasons why you would or would not give your body organs for transplant after your death.

Answers will vary, but you should adopt a position on the issue of leaving your body parts for transplant. You should include at least three reasons why you would or would not give your body organs for transplant after your death.

2. Based on the data provided in the graphs and your knowledge of these diseases, sketch a graph for each disease, similar to the ones provided, of what they would probably look like prior to 1900 when no statistical records were kept. Keep in mind that no vaccines existed for these diseases during this time.

A sketch of a graph for each disease prior to 1900 would probably include increasing and decreasing numbers of cases similar to those shown for each graph but at a higher level than that shown at the beginning of each graph.

Key to the Assignment Booklet

Section 1 Assignment (20 marks)

- (4 marks) 1. Outline the historical discovery and development of the light microscope.

Several of the following points should be mentioned:

- *The microscope was first developed by Janssen Brothers.*
- *A microscope was made by combining lenses together to achieve magnification.*
- *Leeuwenhoek achieved magnification up to 270 times with his microscope.*
- *Each excellent specimen was sealed in the microscope and then required the building of a new microscope.*
- *He was a very skilled lenses grinder but never taught his skills to anyone.*
- *It was 200 years before technology achieved better microscopes.*

- (2 marks) 2. In what two ways has the electron microscope contributed to a better understanding of disease microorganisms than the light microscope?

The high resolution and magnification of an electron microscope has revealed the structure of viruses and other structures which are invisible under a light microscope.

- (4 marks) 3. a. Explain the advantages and limitations in using a light microscope.

Live specimens can be observed under a light microscope, but resolution and magnification are limited.

- b. Explain the advantages and limitations in using an electron microscope.

An electron microscope has high resolution and magnification, but live specimens cannot be observed.

- (4 marks) 4. Suggest a specimen in which its details can be studied by using

- a. a magnifying glass

Specimens which can be studied by using a magnifying glass include such items as small insects, money, and printing.

- b. a low-powered light microscope

Specimens which can be studied by using a low-powered light microscope include human hair, cells, etc.

- c. a high-powered light microscope

Specimens which can be studied by using a high-powered light microscope include specimens such as blood samples and bacteria.

- d. an electron microscope

Specimens which can be studied by using an electron microscope include viruses and large molecules.

- (6 marks) 5. Recommend a magnifying instrument and a magnification which is best for studying the following specimens. Explain the reason for your recommendation.

- a. the flag appearing on the buildings of a \$5 bill

A magnifying glass or a binocular microscope at highest power are the best choices since the specimens are opaque.

- b. white blood cells

For a detailed view, a light microscope at high power is the best choice due to the small size of the specimens.

- c. blood circulation in the tail of a goldfish

The best choice is a light microscope at low power for a general view of the circulation through the blood vessels of a living specimen.

- d. nuclear cell material

An electron microscope at high magnification is the best choice due to the very small size of the contents of a nucleus.

- e. animal cheek cells

A light microscope used at power for a general view and high power for the detail of animal cheek cells is the best choice.

- f. tissue paper

A magnifying glass or a binocular microscope at highest power are the best choices since tissue paper is opaque.

Section 2 Assignment (30 marks)

- (10 marks) 1. Once you get a viral disease, your body develops an immunity to protect you from contracting that viral disease again. Keeping this statement in mind, answer the following questions.

- a. Why do people often catch more than one cold in their lifetime?

There are more than 200 different viruses that cause colds; you develop an immunity to each one of them only when you contract each type of virus.

- b. What are your body's natural defense zones?

Natural defence zones in your body are either external, such as skin, or internal, such as white blood cells.

- c. How can antigens get past your external body defense system?

Antigens can get past your external body defence system in any of the following ways:

- *through body openings*
- *through sores or open wounds*
- *through needles or other ways of injection*

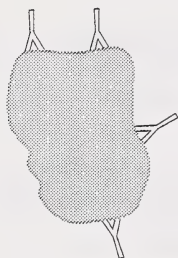
- d. Where and how does a baby get its antibodies?

A fetus gets its antibodies through the placenta from the mother and from mother's breast milk if the baby breast feeds.

- e. Where are antibodies produced?

Antibodies are produced inside your body by special white blood cells.

- (4 marks) 2. Use a diagram to show how antibodies are able to neutralize a pathogen. Explain your diagram.



Antibodies attach themselves to the antigen and neutralize it.

- (2 marks) 3. Explain the difference between a phagocyte and a macrophage.

A phagocyte is another name for a white blood cell, and a macrophage is a large cell that engulfs antigens.

- (2 marks) 4. Explain how doctors cause your body to produce memory cells.

Doctors cause your body to produce memory cells by the immunization process.

- (2 marks) 5. Why is it dangerous to have mumps as an adult?

It is dangerous to have mumps as an adult because swelling of the testicles can cause sterility.

- (2 marks) 6. Why can't you be immunized against the common cold?

There are too many viruses (over 200) that can cause a cold; you would need a vaccine for each one of them to be immunized against the common cold.

- (6 marks) 7. a. What common substances could a person be allergic to?

A person could be allergic to such things as nuts, mould, certain foods, milk, pollen, animals, dust, or insect bites.

- b. What are some symptoms of an allergic reaction?

Some symptoms of an allergic reaction could include the following:

- difficulty in breathing
- swollen eyes
- runny nose
- restriction in the throat (choking)

- c. What is the function of a memory cell?

A memory cell receives a signal alerting the body to the presence of an antigen causing the cell to explode and release chemicals into the blood stream.

- (2 marks) 8. If you were allergic to animals and were going to visit a friend who had a dog, what could you do to make your visit tolerable?

To make your visit tolerable, you could take antihistamines before you get there.

Section 3 Assignment (32 marks)

- (6 marks) 1. a. Why was Lister considered to be a forerunner in the field of modern medicine?

Joseph Lister was the first to use an antiseptic and aseptic methods with excellent post-operative results.

- b. What chemical did Lister use to kill germs?

Lister used carbolic acid to kill germs.

- c. What could happen if a person treated an open wound with unwashed hands?

If a person treated an open wound with unwashed hands, the wound could become infected by microorganisms from the unwashed hands.

- (4 marks) 2. Jenner found that cowpox produced an immunity to smallpox. How did he come to this conclusion?

Jenner noticed that milkmaids who had cowpox did not get smallpox. He hypothesized that cowpox gave immunity to smallpox. He tested his theory by infecting a small boy with cowpox. Following a mild case of cowpox, the boy's arm was scratched with smallpox. When the boy did not develop smallpox Jenner concluded that the cowpox infection produced an immunity to smallpox.

- (4 marks) 3. Explain what vaccines are and what they do.

Vaccines are any substances used to produce immunity against specific diseases. They stimulate the body to produce antibodies against disease organisms.

- (2 marks) 4. Explain where antibodies which are injected directly into your body are produced.

Antibodies that are injected directly into your body are produced by other organisms.

- (4 marks) 5. Are there any disadvantages to injecting antibodies into the body? Explain.

One disadvantage of using antibodies that are injected into the body is that the immunity is short-lived.

- (4 marks) 6. Explain the difference between active and passive immunity.

Passive immunity results from antibodies that are injected directly into your body.

Active immunity results from antibodies already present in the body. Memory cells alert the body if a disease-causing organism is recognized.

- (2 marks) 7. What are four ways you can become immune to a disease? Explain.

You can become immune to a disease through the following:

- *previous contact with the disease*
- *vaccination*
- *injection of antibodies directly into the body*
- *wonder drugs*

- (2 marks) 8. What are some of the problems that could be created by penicillin?

Problems with penicillin could include the following:

- *Some people are allergic to penicillin.*
- *Careless use of penicillin can make it ineffective against common diseases.*
- *Surviving bacteria can develop a resistance to penicillin.*
- *Penicillin also kills some helpful bacteria.*

- (2 marks) 9. How was the growth hormone produced at one time and how is it produced now?

Growth hormone was obtained from the thyroid glands of dead people but is now produced by bacteria with a gene spliced into them.

- (2 marks) 10. What is the difference between gene splicing and cloning?

Cloning involves the creation of an exact genetic duplicate of an entire cell or organism, whereas gene splicing involves the creation of a new organism which can produce specific chemicals or one which has certain new characteristics.

Section 4 Assignment (18 marks)

- (4 marks) 1. a. Why doesn't the smallpox vaccine immunize you against polio?

Antibodies only recognize one type of microorganism; smallpox antibodies are ineffective against the polio virus.

- b. What immunization shots could you receive in elementary school?

Some shots you received in elementary school could include diphtheria, mumps, rubella, tetanus, measles, and polio vaccines.

- (3 marks) 2. Today organ transplants are a common occurrence. Answer the following questions:

- a. What organs are commonly transplanted?

Organs that have been transplanted are the heart, kidneys, and eye corneas.

- b. What problems are associated with heart transplants?

Problems associated with heart transplants include the following:

- *tissue rejection*
- *secondary infection*
- *cost*
- *availability*

- c. Why is cyclosporin used, and what is its disadvantage or side effect?

Cyclosporin prevents the production of antibodies that would signal the immunization system to attack the transplanted organ. It suppresses other aspects of the immunization system, and a person is then susceptible to many types of diseases.

- (2 marks) 3. What is the difference between a transplant and an implant?

A transplant is the replacement of an organ or organ part with another similar part from another organism. In an implant, part of the organ is replaced with an artificial device.

- (2 marks) 4. What are some parts of the body that can be replaced with artificial parts?

Parts of the body that can be replaced with artificial parts include limbs, lenses, blood vessels, and heart valves.

- (1 mark) 5. What is the function of a heart pacemaker?

A heart pacemaker regulates the heart beat.

- (2 marks) 6. What are cataracts, and how are they removed?

A cataract is the clouding of an eye lens. Cataracts are removed by laser surgery.

- (2 marks) 7. What is amniocentesis, and what conditions can be detected by having it done?

Amniocentesis is the study of cells in the fluid withdrawn from the sac surrounding the embryo. The procedure could detect

- *Down's syndrome*
- *hemophilia*
- *Duchenne's muscular dystrophy*
- *Fabry's disease*

- (1 mark) 8. Name one product of biomedical technology.

Biomedical technology can be applied to achieve

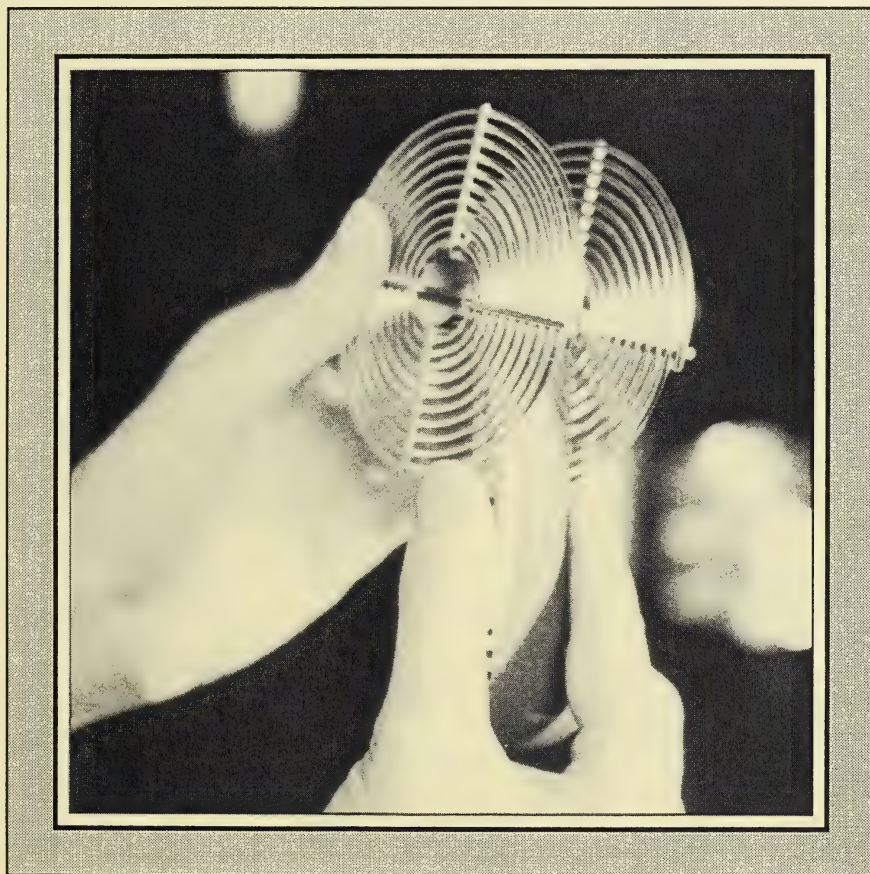
- *selective cattle breeding*
- *alteration and improvement of plants*
- *development of disease-resistant strains of fruits, vegetables, and grains*

- (1 mark) 9. Why was the first test tube baby not really a test tube baby?

The egg of the first test tube baby, Louise Brown, was fertilized outside the body but developed inside a womb, not in a test tube.

SCIENCE 24

Module 5: Exploring Metals

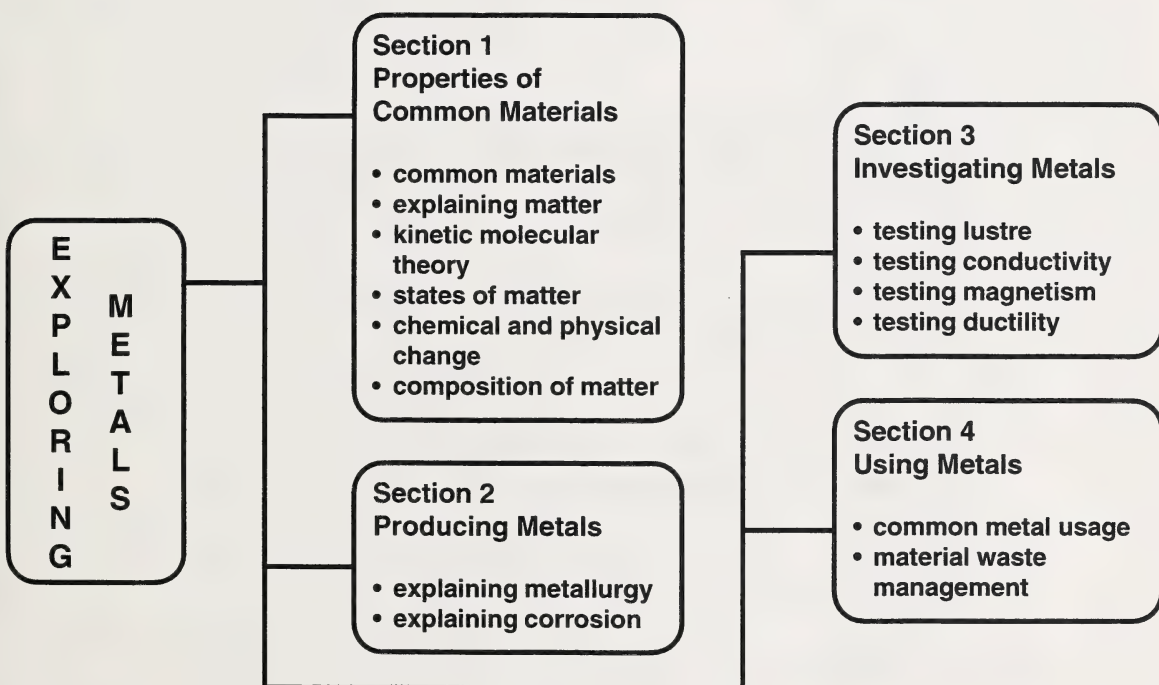


Learning Facilitator's Manual

Module 5: Exploring Metals – Overview

Numerous materials have been used in making useful items and products. The emphasis in this module is on the properties and applications of metal materials. The development of metallurgy to extract common metals from their mineral sources and changing them into useful items and products is approached from a historical and contemporary viewpoint.

Properties of matter, kinetic molecular theory, and behaviour of matter's component structure are explored. As well, investigations through controlled experimentation are designed to develop an appreciation for the significant role that metals play in modern society.



Materials and Equipment

The following is a list of materials and equipment necessary to complete the investigations and activities in Module 5.

Section 1: Activity 4

- bag of miniature marshmallows (multi-coloured ones work best)
- 1 L clean jar

Section 1: Enrichment

- red or blue food colouring
- two clear glass containers or two clear plastic cups
- cold and hot water

Section 2: Activity 2

- 8 10-cm lengths of iron wire or common uncoated nails
- 8 test tubes, or glass containers, or clear plastic cups
- 1 10-cm length of copper wire
- steel wool
- transparent tape
- 5 mL table salt
- 3 mL copper(II) sulphate, CuSO_4 , or copper(II) carbonate, CuCO_3
- 10 mL hydrochloric acid

Section 3: Activity 1

- sample of tarnished silverware or silver-plated object
- large plastic container (such as an ice cream pail or dish pan)
- aluminum foil
- 125 mL washing soda (Na_2CO_3), baking soda (NaHCO_3), or a water softener solution
- hot tap water
- stopwatch or a clock or watch which measures seconds

Section 3: Activity 2

Part A

- flashlight battery
- bulb socket
- bulb (1.2 V-1.5 V)
- 3 30-cm lengths of insulated copper wire
- steel wool
- electrical or transparent tape

Part B

- conductivity tester
- collection of metal and nonmetal items (see suggested items)

Metal	Suggested Test Item
Aluminum (Al)	pop can, aluminum, foil, aluminum wire, cooking pot or pan, foil cookware
Lead (Pb)	lead fish line sinker, lead shot, solder, car battery posts
Zinc (Zn)	dead flashlight battery container with plastic cover removed, galvanized sheet metal, garbage can, or furnace pipe, electrical outlet box
Iron (Fe)	coat hanger, bolt or nail, steel wool, stainless steel cutlery, paper clip, barbed wire
Copper (Cu)	copper wire, brass key, household water pipe
Tin (Sn)	tin can, solder, pewter ware
Silver (Ag)	silverware, jewellery (bracelet, earring), nickel, dime, or quarter dated before 1968
Nickel (Ni)	nickel, dime, or quarter dated after 1968, alnico magnet
Chromium (Cr)	water faucet, water closet tube (tube from toilet tank to water supply), car bumper

Nonmetal	Suggested Test Item
Carbon (C)	pencil lead, charcoal briquette, carbon paper, typing ribbon, graphite
Wood	paper, cardboard box, desk top, pencil, piece of lumber or plywood
Plastic	margarine, sour cream, or cottage cheese container, plastic cutlery, cassette or CD case, plastic grocery or shopping bag, plastic pop bottle
Glass	window, jar, pop bottle, light bulb

Section 3: Activity 3

- one magnet
- your collection of metal objects used in the previous investigation

Section 3: Activity 4

- your collection of objects used in the previous investigations (Do not use glass objects in this investigation.)

Additional Resources

Metallurgy and Corrosion. Alchem Elective. J.M. LeBel Enterprises Ltd., 1979.

Mining: What Mining Means to Canada. Ontario: The Mining Association of Canada, 1979.

Possible Media

Video *Steel for the West* (available on loan from Stelco Steel)

Video *Steel in America* (available on loan from Stelco Steel)

Video *Visitors Guide to Edmonton Works* (available on loan from Stelco Steel)

Suggested Enrichment Activities

The following associations or firms may be contacted for information, speakers, or possible field trips. Check with the information operator for current telephone numbers.

- Association of Professional Engineers, Geologists, and Geophysicists of Alberta (APEGGA), Edmonton. Speakers can offer career counselling, curriculum demonstrations, or presentations.
- Stelco Steel, Edmonton. A field trip to Stelco Steel will enable students to observe conversion of scrap iron into molten iron and recycled iron into rebar, wire, and other useful products.
- NAIT/SAIT, Edmonton and Calgary. Speakers may outline careers and programs available in welding, auto body repairs, and other trades or materials technologies. Arrange a field trip to NAIT, Materials Dept., Edmonton, to observe the radiography facility. Plastic injection molding may also be observed at NAIT/SAIT. Both facilities also have annual "Open Houses."
- Sherritt Gordon Limited, Fort Saskatchewan. Students may observe the production of nickel (and cobalt) from concentrated ore and the minting of coins and medallions.
- Alberta Research Council, Edmonton.
- U of A Engineering: Mining, Metallurgical, and Petroleum Dept., Edmonton. (See the metallurgy process).

- Alberta Microelectronic Centre, Edmonton. This firm uses applications such as thin film deposition, sputtering, micromachining, and metal-ceramic integrated chips.
- Frontier Engineering Research (C-FER), Edmonton. Observe large scale metals, plastics, and composite materials testing at cold temperatures; investigation of materials properties; and corrosion rates applicable to oilfield or marine environments.
- The Laser Institute, Edmonton. Observe metal cutting, laser machinery, and use of lasers and fibre optics.

Evaluation

The evaluation of this module will be based on four assignments:

Section 1 Assignment	30 marks
Section 2 Assignment	26 marks
Section 3 Assignment	20 marks
Section 4 Assignment	<u>24 marks</u>
TOTAL	100 marks

Section 1: Properties of Common Materials

Section 1 examines the properties of common materials. Students should recognize that materials are a form of matter whose basic structural unit or composition is an atom. The kinetic molecular theory is used to explain the behaviour of atoms and molecules. The importance of metals as a commonly used material in modern society is stressed. Students will evaluate several common materials through scientific investigation.

Section 1: Activity 1

1. Suggest an object or product that can be made from the following common materials.

Answers will vary. Some objects or products that can be made from the common materials are listed.

- a. metal

vehicles, machinery, appliances

- b. plastic

toys, containers, garbage bags

- c. synthetic fibre

clothing, carpets, upholstery

- d. natural fibre

sweaters, blankets, canvas tents

- e. fabric

dress material, drapery, bedding

- f. ceramic

vases, figurines, tiles, dinnerware

- g. glass

windows, lenses, light bulbs

- h. wood

furniture, hockey sticks, fences, buildings

- i. rubber

tires, boots, elastics, erasers

2. Which of the materials from those previous question do you think is most widely used. Why?

Metal is one of the widely used materials because it is abundant, it can easily be changed into the desired shape, it is strong, and it will last if protected. Wood is also one of the most widely used materials because it is abundant, inexpensive, easy to work with, and can easily be changed into the desired shape.

3. Identify which of the following items are homogeneous materials and which are heterogeneous materials. List each item under the appropriate heading.

looney coin	credit card	milk	violin
house	newspaper	beer bottle	toilet bowl/tank
cutlery	chesterfield	electric cord	

Homogeneous Material	Heterogeneous Material
<i>milk</i> <i>beer bottle</i> <i>cutlery</i> <i>credit card</i> <i>looney coin</i>	<i>violin</i> <i>newspaper</i> <i>house</i> <i>electric cord</i> <i>chesterfield</i> <i>toilet bowl/tank</i>

4. Select any **six** of the following items and identify the materials used to make them. You may want to specify the parts of the item. An example is shown.

Answers may vary.

Item	Materials
scissors	<ul style="list-style-type: none"> • steel • plastic • chrome
gas barbecue	<ul style="list-style-type: none"> • <i>metal firebox</i> • <i>rubber wheels</i> • <i>wood racks</i> • <i>plastic dials</i>
hammer	<ul style="list-style-type: none"> • <i>metal head</i> • <i>wood, fibreglass, or rubber handle</i>

Item	Materials
car	<ul style="list-style-type: none"> • <i>rubber tires</i> • <i>metal body</i> • <i>fabric seats</i> • <i>plastic instrument panel</i> • <i>glass windows</i>
airplane	<ul style="list-style-type: none"> • <i>rubber tires</i> • <i>metal body</i> • <i>fabric seats</i> • <i>glass windows</i>
microscope	<ul style="list-style-type: none"> • <i>plastic or metal body</i> • <i>glass lenses</i>
sneakers	<ul style="list-style-type: none"> • <i>rubber soles</i> • <i>plastic or synthetic uppers</i> • <i>fabric laces</i>
personal computer	<ul style="list-style-type: none"> • <i>plastic body</i> • <i>metal circuits</i> • <i>glass screen</i>
sleeping bag	<ul style="list-style-type: none"> • <i>metal zipper</i> • <i>natural or synthetic fill</i> • <i>fabric bag</i>
hockey stick	<ul style="list-style-type: none"> • <i>wood or metal shaft and blade</i> • <i>plastic reinforcement</i> • <i>other glue</i>
pen	<ul style="list-style-type: none"> • <i>plastic or metal body</i> • <i>ink</i>

Item	Materials
guitar	<ul style="list-style-type: none"> • wood or plastic body • metal or plastic strings
toaster	<ul style="list-style-type: none"> • metal or plastic body • metal heat coil • metal and rubber cord

Section 1: Activity 2

1. Why are the three things in the previous diagram classified as matter?

The objects are classified as matter because they have mass and occupy space.

2. If molecules were broken apart, what would the result be?

Atoms would be the result of molecules that were broken apart.

3. How many different kinds of atoms are found in the sugar (glucose) molecule?

There are three kinds of atoms that are found in the sugar molecule: carbon, oxygen, and hydrogen.

4. What is the total number of atoms in the sugar (glucose) molecule?

There are twenty-four atoms in the sugar molecule.

Section 1: Activity 3

1. Match the following ideas of the kinetic molecular theory with the corresponding human activity.

<u>D</u>	a. Molecules are constantly in motion.	A. Dancers on a dance floor move about all over the dance floor.
<u>F</u>	b. Molecules in a solid move within a fixed position.	B. Dancers on a dance floor move past one another.
<u>B</u>	c. Molecules in a liquid slide past one another.	C. Dancers dance faster when the tempo of the music increases.

- | | | |
|--------------|--|---|
| <u> E </u> | d. Molecules in a gas state move faster and farther than molecules in a liquid or solid state. | D. People are constantly moving twenty-four hours a day. |
| <u> A </u> | e. Molecules in a liquid move randomly. | E. The motion of players in a basketball game is much faster than the motion of dancers or students in a classroom. |
| <u> C </u> | f. Molecules move faster when the substance is heated. | F. A classroom of students quietly reading at their desks is in constant motion. |

2. If the dancers are analogous to the molecules of a liquid, to what is the music analogous?

The music is analogous to heat. If the amount of heat is reduced, the molecules can slow down and form a solid.

Section 1: Activity 4

1. Did you see the marshmallows moving around in the jar?

No, you cannot see the marshmallows moving around in the jar.

2. The marshmallows are models of the atom. What is the state of matter that is being modelled in this step? Explain.

A solid is being modelled. The marshmallows are not free to move about in the jar just as the molecules in a solid do not freely move about.

3. Did you see the marshmallows moving around in the jar?

Yes, you can see the marshmallows moving around in the jar.

4. What is the state of matter that is being modelled in this step? Explain.

A liquid is being modelled. The marshmallows slide over one another as the jar is tilted from side to side just as the molecules in a liquid move.

5. Did you see the marshmallows moving around in the jar?

Yes, you can see the marshmallows moving around in the jar.

6. What state of matter is being modelled in this step? Explain.

A gas is being modelled. The marshmallows move vigorously and fill the entire jar just as the molecules in a gas move vigorously and take up space.

7. Models often fail to completely describe something. What was the most serious flaw in the marshmallow model of a liquid?

A liquid can occupy the entire volume. If you fill the jar with marshmallows, you are modelling a solid; the marshmallows are not free to move.

8. Why would multi-coloured marshmallows work better than plain, white marshmallows?

You can easily see the multi-coloured marshmallows shift position compared to plain, white marshmallows.

9. Under each heading (Solids, Liquids, and Gases), list five common household items.

Answers will vary.

Solids	Liquids	Gases
<ul style="list-style-type: none"> • bar of soap • fork and spoon • drinking glass • shovel • canned food containers • stove and other appliances • clock • toaster 	<ul style="list-style-type: none"> • paint thinner • milk • soda pop • bleach • household cleaners • vinegar • shampoo • gasoline for lawn mower 	<ul style="list-style-type: none"> • carbon dioxide in pop • natural gas • furnace exhaust • moisture in air • ammonia vapour from cleaners • aerosol can propellents • air • Freon gas in refrigerator coils

Section 1: Activity 5

1. Using the scientific names, identify the phase changes involved in the following observations.

- a. Dry ice is made from carbon dioxide gas.

sublimation

- b. Surfaces of lakes freeze during winter.

solidifying

- c. Mothballs produce an odour and get smaller with time.

sublimation

- d. Wet clothes become dry on a clothes line.

evaporation

- e. Eye glasses fog up in winter when a person enters a warm room from outdoors.

condensation

- f. Icebergs get smaller as they enter warmer waters.

fusion

- g. You can see your breath when the temperature is 2°C.

condensation

- h. Streets become dry after a rain.

evaporation

- i. Metal is cut with a torch.

fusion

2. For each of the following changes, decide whether the change is chemical or physical, and state the reason why.

- a. Gasoline explodes in the cylinder of a car.

The change is chemical because new substances, carbon dioxide and water vapour, are formed.

- b. Gravel can be crushed into smaller pieces.

The change is physical because the gravel remains the same except it is in smaller pieces.

- c. Milk turns sour.

The change is chemical because a new substance is formed.

- d. Bananas rot.

The change is chemical because a new substance is formed.

- e. Lumber is made from trees.

The change is physical because it is the same substance in a different form.

- f. Sheets of aluminum are pressed into cans.

The change is physical because it is the same substance in a different form.

- g. Silverware tarnishes.

The change is chemical because a new substance, silver oxide, is formed.

- h. Nails are made from iron.

The change is physical because it is the same substance in a different form.

Section 1: Activity 6

1. Use the periodic table to complete the following table.

Atomic Number	Symbol	Name
1	<i>H</i>	<i>hydrogen</i>
3	Li	<i>lithium</i>
6	<i>C</i>	carbon
12	<i>Mg</i>	<i>magnesium</i>
15	P	<i>phosphorus</i>
17	<i>Cl</i>	chlorine
20	<i>Ca</i>	<i>calcium</i>
26	Fe	<i>iron</i>
32	<i>Ge</i>	germanium
47	Ag	<i>silver</i>
74	<i>W</i>	<i>tungsten</i>
80	<i>Hg</i>	mercury

2. If *element* is another word for mineral, why is it used to describe the substances in the periodic table?

Mineral was the word used to describe the known elements in ancient times. Those known elements were mainly metals and the components of rock. After gaseous elements were discovered, it must have seemed incorrect to call a gas a mineral. The word element is used to describe all elements that are solids, liquids, and gases. Mineral describes the solid elements only.

3. How many elements have been discovered so far?

To date, 109 elements have been discovered. Element 108 has not been discovered. Elements 109 and 110 have been discovered, but there is little verification of the discoveries.

4. Use your periodic table to classify the following elements as metals or nonmetals.

Symbol/Name	Metal/Nonmetal
iridium	<i>metal</i>
Te	<i>nonmetal</i>
vanadium	<i>metal</i>
Cr	<i>metal</i>
Au	<i>metal</i>
argon	<i>nonmetal</i>
selenium	<i>nonmetal</i>
F	<i>nonmetal</i>
barium	<i>metal</i>
Br	<i>nonmetal</i>

5. State which of the following substances are elements and which are compounds. Compounds cannot be found on the periodic table.

carbon dioxide	baking soda	iron	mercury
alcohol	propane	table sugar	silver
calcium	carbon	zinc	vinegar

Element	Compound
<i>calcium</i> <i>carbon</i> <i>iron</i> <i>zinc</i> <i>mercury</i> <i>silver</i>	<i>carbon dioxide</i> <i>alcohol</i> <i>baking soda</i> <i>propane</i> <i>table sugar</i> <i>vinegar</i>

6. State which of the following substances are mixtures and which are not mixtures.

- | | |
|-------------|-------------------|
| • soil | • distilled water |
| • sugar | • sea water |
| • air | • zinc |
| • crude oil | • milk |

Mixtures	Not Mixtures
<i>soil</i> <i>air</i> <i>sea water</i> <i>crude oil</i> <i>milk</i>	<i>sugar</i> <i>distilled water</i> <i>zinc</i>

7. What are some of the main ingredients or components of the following mixtures?

a. soft drinks

Soft drinks are composed of water, sugar, flavour, and colour.

b. air

Air is composed of nitrogen, oxygen, and carbon dioxide.

c. paint

The main ingredients of paint are pigment or colouring, solvents (water, linseed oil, or a petroleum base), and solutes such as latex or oils.

d. pavement

The components of pavement are tar or asphalt and gravel.

e. 10-carat gold ring

A 10-carat gold ring is composed of gold, silver, copper, and possibly other metals.

Section 1: Follow-up Activities

Extra Help

1. Identify some common materials used to make the following products.

a. cassette tape

plastic, iron, chromium

b. mirror

glass, silver

c. ski suit

fabric, plastics

d. chess pieces

wood, plastic, metal, ceramics

- e. pots and pans

metal, plastic

- f. flower pot

ceramic, plastic, wood, glass, metal

- g. kitchen stove

metal, glass, plastic

- h. cardboard box

wood

- i. ketchup bottle

glass, plastic

2. Why is a cloud considered to be matter?

A cloud has mass and it occupies space. It is usually composed of small drops of liquid water or small crystals of ice.

3. Place a T in front of the statements that are true and an F for those that are false. Correct any false statements.

 T a. Nylon is a material; therefore, it is a form of matter.

 T b. Air is matter; therefore, it has mass and occupies space.

 F c. A molecule is the smallest particle of an element.

An atom is the smallest particle of an element.

 F d. The kinetic molecular theory states that when water freezes, molecular motion ceases.

The kinetic molecular theory states that when water freezes, the molecules vibrate in fixed places. The theory states that all motion ceases at -273.15°C .

 T e. The kinetic molecular theory explains why a gas does not have a definite shape.

 F f. According to the kinetic molecular theory, gases have the least amount of space between their molecules.

According to the kinetic molecular theory, gases have the greatest amount of space between their molecules.

- T g. When you barbecue hamburgers, a chemical change occurs.
- T h. A molecular formula only indicates the type of atoms present in the molecule.
- T i. Antimony is an example of an element.
- T j. Carbon dioxide is an example of a compound.
- T k. Air, which is a gas, can be changed into a liquid.

4. Fill in the blanks.

- a. Sulphur is an element; therefore, it contains only *one kind* of atom.
- b. The formula for baking soda is NaHCO_3 . The elements that baking soda is made from are *sodium, hydrogen, carbon, and oxygen*.
- c. The space between molecules in gases is *very large*.
- d. The state of matter that has a definite volume is a *solid or liquid*.

5. Read each question and decide which of the choices best completes the statement.

- C a. Aluminum is considered to be an element because
- A. it is widely used
- B. its atoms can only vibrate
- C. it only contains identical atoms
- D. it occupies space and has mass

- A b. Concrete is made from water, cement, sand, and gravel. It is an example of
- A. a mixture
- B. an element
- C. a compound
- D. a molecule

Enrichment

1. Some of the essential elements needed by your body are listed. Use any outside reference source, such as a biology textbook or encyclopedia, to find the specific use for any **ten** of the following elements that your body needs.

- a. potassium

Potassium is required for proper muscle and nerve function.

b. magnesium

Magnesium regulates nerve and muscle action.

c. sodium

Sodium regulates the balance of body fluids and transmits nerve impulses.

d. calcium

Calcium aids bone structure, muscle contractions, and blood clotting.

e. chlorine

Chlorine provides an acid-base balance.

f. phosphorus

Phosphorous is necessary for healthy bone structure.

g. copper

Copper is necessary for hemoglobin formation.

h. cobalt

Cobalt is essential for hemoglobin formation.

i. zinc

Zinc is important in many enzymes.

j. iodine

Iodine is part of the thyroid hormone.

k. fluorine

Fluorine hardens bones and teeth.

l. iron

Iron reduces bacterial action in the mouth, and it is an important component of hemoglobin.

m. sulphur

Sulphur is an important part of proteins (such as insulin).

2. In which container does the food colouring spread more quickly?

The container with hot water promotes the spreading of food colouring more quickly.

3. What causes the food colouring to diffuse in water in Step A?

The collision of water molecules with food colouring molecules causes the food colouring to diffuse in water.

4. From your observation of Step A, what conclusion can be made about the effect of temperature on the diffusion of food colouring in the water?

Temperature increases collisions since diffusion occurs more quickly in warm water.

5. What conclusion can be made about the effect of concentration on the diffusion of the colouring in water in Step B?

Diffusion occurs more quickly; therefore, there must be more collisions involving food colouring molecules occurring when the concentration increases.

6. Why does Brownian movement of particles occur in gases such as air and in liquids such as water?

Since molecules are in motion, they collide with one another. Gas and liquid molecules collide with other molecules.

Section 2: Producing Metals

Section 2 serves as an introduction to metals and the development of metallurgy. Students should learn to recognize metals, nonmetals, and alloy properties. They will also learn that metals are extracted from mineral ores and that metal oxides are a form of corrosion. Various methods used in preventing corrosion will be reviewed.

Section 2: Activity 1

1. Why is gold found in its pure form while most other metals are found combined with other elements?

Gold is very stable and unreactive with most elements or compounds. There are some elements, such as arsenic and mercury, which react with gold, but these elements are not commonly found in their pure state.

2. Who were the first metallurgists?

Prehistoric people worked with gold, copper, and tin. Thus, they were the first metallurgists.

3. Why was bronze preferred to copper?

Bronze is harder and stronger than copper.

4. The carbon from charcoal used in smelting copper would contaminate the metal. Why doesn't carbon contaminate iron in the same way?

Carbon does contaminate iron in the same way, but if the amount of carbon is just right, steel is produced instead of iron. The steel can be stronger and harder than pure iron.

5. Most of the modern metals were discovered in the last two or three hundred years. Why were all these metals so difficult to discover?

Many of the metals cannot be refined by smelting. Until chemical, physical, and electrical processes were discovered, many metals remained hidden in their ores. Other metals are found in very low concentrations so that conventional methods could not detect the presence of these metals.

6. Canada produces a large amount of aluminum each year, yet Canada has to import all of the bauxite used. Why do they have an aluminum plant in British Columbia?

The ore, bauxite, and a large supply of inexpensive electricity are required. The bauxite is imported from Brazil, Guyana, and Guinea and it is refined where the electrical power is the least expensive, which could be in British Columbia.

7. Predict whether alloys or plated steel would be used in each of the following applications.

- a. eavestrough:

galvanized steel, zinc-plated steel, aluminum

- b. car bumper:

chrome-plated steel

- c. screwdriver:

chrome-plated steel

- d. wrench:

vanadium steel

- e. eating utensils:

sterling silver or stainless steel

- f. frying pans:

cast iron, aluminum, stainless steel

g. plumbing pipes:

copper

h. knives:

stainless steel

8. Using the periodic table in the appendix, record the melting point for the following metals.

a. iron

1535°C

b. copper

1083°C

c. lead

328°C

d. antimony

631°C

e. tin

232°C

f. silver

962°C

g. mercury

-39°C

h. gallium

29.8°C

Section 2: Activity 2

1. Why do you think an iron nail rusts so quickly compared to an aluminum nail?

Iron is the easiest to obtain from the ore and therefore will oxidize the slowest. However, iron does not form a protective coating of iron oxide (rust) as does aluminum. The aluminum oxide coating forms very quickly, but then it protects the aluminum metal from further oxidation.

2. Why is a metal garbage can galvanized?

The metal garbage can is galvanized to protect it from rusting. Metal garbage cans are made from steel which is then plated with zinc. The zinc quickly oxidizes but the oxide layer prevents further oxidation. Galvanizing is the coating of zinc onto another metal, usually steel.

3. Complete and record your observations in the following chart.

Corrosion of Iron			
Container Number	Content Descriptions	Day 1 Observations	Day 2 Observations
1	<i>bent nail in water</i>	<i>more rusting at bend</i>	<i>more rusting at bend</i>
2	<i>nail wrapped in transparent in water</i>	<i>no rust under tape</i>	<i>no rust under tape</i>
3	<i>nail wrapped with Cu in water</i>	<i>no rust under Cu</i>	<i>no rust under Cu</i>
4	<i>clean nail in water</i>	<i>rusted</i>	<i>rusted</i>
5	<i>nail in NaCl</i>	<i>no rust</i>	<i>no rust</i>
6	<i>nail in CuSO₄</i>	<i>no rust</i>	<i>corrosion</i>
7	<i>nail in HCl</i>	<i>no rust</i>	<i>no corrosion</i>
8	<i>clean nail in empty container</i>	<i>no rust</i>	<i>no corrosion</i>

4. Which container is the control?

Container 8 is the control.

5. In which container did the iron rust the most?

The nail that corroded the most was the one in the CuSO₄ mixture, which was container 6.

6. In which container did the iron rust the least?

The nail that corroded the least was the one in air, which was container 8.

7. What generalization or conclusion can be made about the rusting of iron?

For the rusting of iron to occur, water is needed. Rusting will occur faster where the iron is bent.

8. Something occurred in containers 6 and 7 that was different from the rusting process in containers 1 through 4. Can you explain what happened that was different?

In container 6 you should notice corrosion that is different and faster than the rusting in containers 1 to 4. The corrosion you see is actually copper that is plating onto the nail. Look carefully and see if you can see a red or copper-coloured metal on the nail.

There are tiny bubbles being produced on the nail in container 7. This indicates a chemical reaction but there is no corrosion visible. The hydrochloric acid is reacting with the iron, and hydrogen gas is being produced. The iron is being eaten away by the acid. Once all of this acid is used up you will start to see rust forming.

9. Suggest how the paint coat on a car can be broken.

The paint coat on a car can be broken by stones or dents.

10. Suggest four car parts where chrome-plating is used.

Some car parts made from chrome-plated steel are given.

- bumper
- headlight trim
- radiator grill
- control level and knobs
- door opener
- window crank handle

11. Why do automakers chrome-plate these kinds of parts?

Chrome-plating produces a bright, shiny surface which is highly resistant to corrosion. Bumpers, trim, and handles enhance the beauty of a car when they shine. Paint could not produce such a surface that would last for years.

12. Why do automakers use galvanized steel to make most body parts?

Galvanized steel is strong, corrosion resistant, and inexpensive.

13. Why is corrosion of an unpainted steel bridge dangerous?

A steel bridge supports a huge amount of weight such as trucks or trains. Corrosion of the steel could lead to the bridge collapsing.

14. Why is impressed voltage cathodic protection preferable to a sacrificial anode for underground storage tanks?

Replacing a battery above ground level is easier than replacing a metal block underground. It is probably an inexpensive and more effective protection.

15. What problems do you think would be created if corrosion of underground storage tanks and pipelines was allowed to occur?

Storage tanks for fuels such as gasoline and diesel fuel and pipelines are a serious potential hazard if they start to leak. Pollution of groundwater and explosion are but two of the risks of an underground storage tank or a pipeline leaking due to corrosion.

16. Why aren't storage tanks, pipelines, and ships tin-plated to protect the steel? (Hint: Think of how long tin cans last.)

Tin-plating is expensive and very hard to completely cast over a large surface. If the tin layer is punctured, the iron or steel underneath will quickly rust away. You might want to see just how fast a tin can will rust. Take a tin can and scratch through the tin coating in a few places. Then leave the can outside in a moist place and see how fast the iron rusts.

Section 2: Follow-up Activities

Extra Help

1. Which of the following metals is produced by smelting?

- A. iron
- B. copper
- C. gold
- D. aluminum

B

2. Which of the following metals was unknown to prehistoric people?

- A. vanadium
- B. gold
- C. lead
- D. copper

A

3. Bronze is an alloy that contains copper and

- A. zinc
- B. nickel
- C. silver
- D. tin

D

4. A metal made by combining two or more metals is called

- A. copper
- B. alloy
- C. corrosion
- D. steel

B

5. The purpose of plating chromium onto steel is to

- A. make it harder
- B. make it stronger
- C. make a dull metal attractive
- D. prevent corrosion

C and D

6. The alloy used by dentists for tooth fillings is

- A. bronze
- B. brass
- C. amalgam
- D. cementum

C

7. A mixture containing a metal compound and impurities is called

- A. an alloy
- B. an ore
- C. azurite
- D. bronze

B

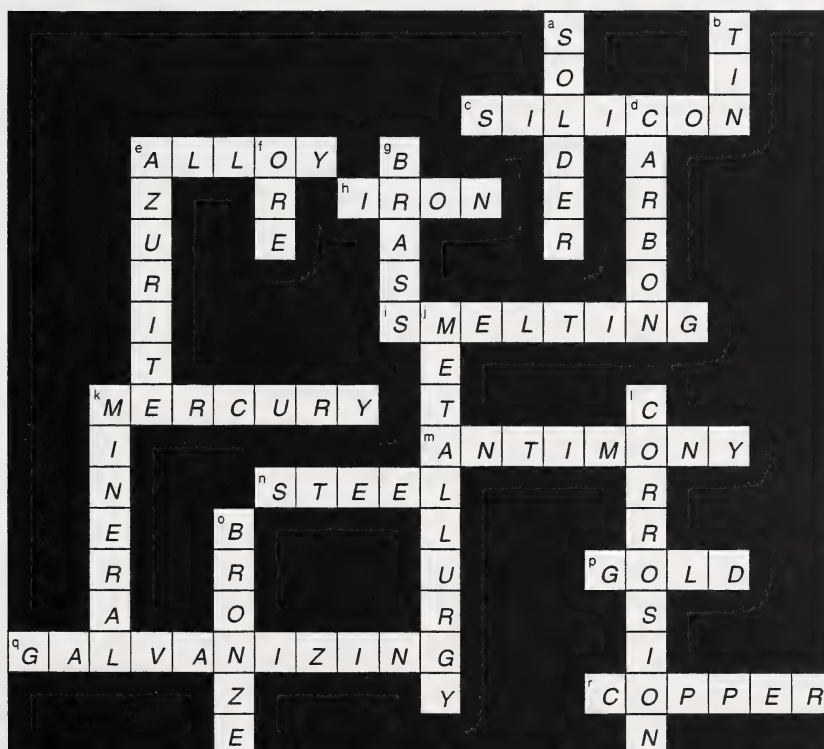
8. Complete the following crossword on metallurgy.

Across

- c. found in microchips
- e. metal mixture
- h. widely used metal
- i. metal extraction using heat
- k. liquid metal
- m. ancient-known metal
- n. iron alloy
- p. precious metal
- q. coating with zinc
- r. early discovered metal

Down

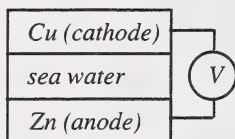
- a. joins metals
- b. used in bronze
- d. found in charcoal
- e. copper mineral
- f. contains minerals
- g. copper and zinc alloy
- j. metal extraction and processing
- k. metal-containing compound
- l. rust is a form of
- o. copper and tin



Enrichment

1. Alessandro Volta produced the first electric battery. He used layers of copper and zinc disks piled one on top of the other. Pads soaked in sea water were placed between the disks.

Use outside reference sources to explain how Volta made his battery and why electricity was produced when two dissimilar metals and an electrolyte are used. A diagram may be helpful.



Zinc metal loses electrons (oxidation) to copper ions which gain the electrons (reduction). Electrons flow from where they are produced (anode) to where they are needed (cathode). Sea water is an electrolyte (electron charge carrier) which allows the electrons to flow from the zinc to the copper.

2. Smelting produces large amounts of sulphur dioxide gas. Sulphur dioxide dissolves in rain water to produce acid rain. Explain why industry's demand for inexpensive metals such as iron is ultimately responsible for acid rain.

Inexpensive metals are often produced by smelting inexpensive coal. This coal contains large amounts of sulphur. When society demands a great amount of inexpensive metals, the amount of sulphur dioxide in the atmosphere increases dramatically. This gas is directly responsible for acid rain.

As is the case too often in modern society the negative effects of a technology are often far removed from the products being consumed.

Section 3: Investigating Metals

Section 3 investigates metal properties. Students will develop scientific inquiry skills through the investigation of objects made from metal materials.

Section 3: Activity 1

1. What is meant when an object is said to be lustrous?

An object that has a shiny surface is said to be lustrous.

2. Why does copper lose its lustre?

Copper combines with oxygen or sulphur to produce a dull, non-lustrous corrosion coating on its surface.

3. Why would some people dislike owning silverware?

Silver combines readily with sulphur in the atmosphere to produce a dull, unattractive tarnish. Therefore, some people may not want to own silverware because frequent polishing is needed to restore and maintain the brilliant shine of polished silver.

4. What is the black film that develops over time on silverware called? Where does it come from?

The black film that develops on silverware is called tarnish. It is formed when silver reacts with the sulphur compounds found in the atmosphere.

5. Record your answers in the observation table.

Answers will vary.

Time in Thirty-second Intervals	Observations
1	<i>Some tarnish starts to disappear.</i>
2	<i>More tarnish disappears; foil starts to discolour.</i>
3	<i>Still more tarnish disappears; foil has black appearance.</i>
4	<i>Very little tarnish remains; foil has black appearance.</i>
5	<i>Almost no tarnish remains; foil has black appearance.</i>
6	<i>No tarnish remains; foil is black.</i>
7	<i>No tarnish remains; foil is black.</i>
8	<i>Object is shiny; no tarnish; and foil is black.</i>
9	<i>Object is shiny; no tarnish; and foil is black.</i>
10	<i>Object is shiny; no tarnish; and and foil is black.</i>

6. How long did it take for the tarnish to begin disappearing?

The tarnish began disappearing immediately.

7. How long did it take for the tarnish to disappear completely?

The tarnish completely disappeared in about three minutes (six time intervals).

8. Describe the appearance of the aluminum foil before the investigation.

The aluminum foil was very shiny before the investigation.

9. Describe the appearance of the aluminum foil at the end of the investigation.

At the end of the investigation the aluminum foil was black.

10. What do you think happened to the tarnish? How?

As the tarnish disappeared from the silver, the aluminum foil became tarnished. No silver was lost in the process; the silver sulphide was turned into silver. This was accomplished by a chemical reaction.

Section 3: Activity 2

1. Why do you think the use of gold, platinum, and silver as conductors is restricted to special circuits only?

Gold, platinum, and silver are only used in special circuits because they are very expensive.

2. Why isn't iron used for household electrical wiring?

Iron is not used for electrical wiring because it is a poor conductor compared to copper and aluminum.

3. Aluminum is almost as good a conductor as copper. Suggest a reason why copper is used in electrical wiring and power lines more than aluminum is used.

Aluminum is a very soft and very ductile metal. Aluminum power lines would stretch and sag because of their softness. Copper is much harder and not as ductile as aluminum. Copper wires can support their own weight.

Aluminum was used for household wiring at one time but corrosion and fire problems developed when aluminum was joined to copper junctions.

4. If the filament of a bulb is made of steel, it would melt. What can you say about the melting point of tungsten?

The melting point of tungsten must be higher than the melting point of iron since it is used in bulb filaments which would melt iron.

5. Edison's original light bulb used a carbon filament. These bulbs lasted a very long time before they would burn out. Can you think of some reasons why the modern light bulbs are made with a tungsten filament when they seem to burn out so quickly?

There are many possible answers. Carbon filaments are very fragile and the slightest bumping can make them break. The tungsten filaments are much more able to handle rough treatment such as shipping.

The efficiency of light bulbs decreases over time because the filament vapourizes slowly and coats the inside of the bulb with a dark film preventing the light from escaping. It is inexpensive and more energy efficient to replace the bulbs than to use them until they only emit a fraction of the light they should. Actually filament type bulbs are made to burn out after a certain number of hours of use.

6. What two metals do you think are used to make the Nichrome alloy?

The two metals used to make the Nichrome alloy are nickel and chromium.

7. Why do you think the element of a stove isn't made of copper?

Although copper is a good conductor, the large size of the stove element requires a metal with a higher resistance like iron. Also copper is much softer than iron and would wear out too quickly.

8. Record your results in the observation table.

Your answers will vary. For each metal and nonmetal one example is given.

Metal	Object	Conductivity
Aluminum (Al)	pop can	yes
Lead (Pb)	solder	yes
Zinc (Zn)	garbage can	yes
Iron (Fe)	steel wool	yes
Copper (Cu)	brass key	yes
Tin (Sn)	tin can	yes
Silver (Ag)	silverware	yes
Nickel (Ni)	post-1968 nickel coin	yes
Chromium (Cr)	water faucet	yes

Nonmetal	Object	Conductivity
Carbon (C)	<i>carbon paper</i>	<i>yes</i>
Wood	<i>paper</i>	<i>no</i>
Plastic	<i>cassette case</i>	<i>no</i>
Glass	<i>jar</i>	<i>no</i>

9. What generalization or conclusion can be made about the conductivity of metal objects?

It can be concluded that metals are electrical conductors.

10. How do metal alloys behave compared to pure metals?

Metal alloys also conduct electricity.

11. What generalization or conclusion can be made about the conductivity of nonmetal objects?

It can be concluded that nonmetals, with the exception of carbon, do not conduct.

12. Which nonmetals conduct electricity?

Carbon is one of the few nonmetals that conducts electricity.

Section 3: Activity 3

1. Suggest other things that depend on the use of magnets.

Some things that depend on the use of magnets are electric motors, security systems, and coin machines.

2. Record your results in the table.

Metal	Object	Magnetism
Aluminum (Al)	<i>pop can</i>	<i>no</i>
Lead (Pb)	<i>solder</i>	<i>no</i>
Zinc (Zn)	<i>garbage can</i>	<i>no</i>
Iron (Fe)	<i>steel wool</i>	<i>yes</i>
Copper (Cu)	<i>brass key</i>	<i>no</i>
Tin (Sn)	<i>tin can</i>	<i>yes</i>
Silver (Ag)	<i>silverware</i>	<i>no</i>
Nickel (Ni)	<i>post-1968 nickel coin</i>	<i>yes</i>
Chromium (Cr)	<i>water faucet</i>	<i>no</i>

Nonmetal	Object	Magnetism
Carbon (C)	<i>carbon paper</i>	<i>no</i>
Wood	<i>paper</i>	<i>no</i>
Plastic	<i>cassette case</i>	<i>no</i>
Glass	<i>jar</i>	<i>no</i>

3. Which materials are magnetic?

Only iron, nickel, and sometimes tin are magnetic. There are no nonmetal materials that are magnetic. There is another uncommon metal, cobalt, which is also magnetic, but the chances of you having a cobalt item are very slim.

4. What generalization or conclusion can be made about the magnetic properties of materials?

Nonmetals are not magnetic. Only iron, nickel, and cobalt are magnetic.

5. How are Fe, Ni, and Co arranged on the periodic table?

Fe, Ni, and Co are arranged side by side on the periodic table. They form a triad.

Section 3: Activity 4

1. Suppose you are given a spoon which looks like metal but feels much too light. How could you test the spoon to see if it was made from a metal?

You could try bending the spoon slightly. If it bends and does not spring back to its original shape it is probably made from a light metal. If it breaks or springs back into its original shape it was probably made from plastic. Metals are malleable and plastics are not.

2. Imagine a person produced a new alloy which was both very light and very malleable. Explain why this alloy would not be suitable for making airplanes.

The wings and supports of an airplane must be light but flexible. If the wings or structure were made from an alloy which is easily bent, the airplane would quickly be bent out of shape and be useless for flying.

3. For each object, tell whether you think it is made of a malleable material. Explain your answer.

- a. car

A car is malleable. In a crash the metal parts are bent out of shape.

- b. pop can

A pop can is malleable. You can crush an empty pop can.

- c. pencil

A pencil is not malleable. If you bend it, it will break.

- d. kitchen knife

A kitchen knife is not malleable. It returns to shape when you try to bend it. Be careful; if you bend it too far it can break in a very dangerous way.

- e. coat hanger

A coat hanger is malleable. If it is made of metal, it will bend. If it is made of plastic, it will not be malleable but it will break.

4. Record your results in the following table.

Sample answers are given. A question mark indicates that that particular object may or may not be malleable. However, the object may be mixed with another metal, thus giving it unique qualities.

Metal	Object	Malleability
Aluminum (Al)	<i>pop can</i>	<i>yes</i>
Lead (Pb)	<i>solder</i>	<i>yes</i>
Zinc (Zn)	<i>garbage can</i>	<i>yes</i>
Iron (Fe)	<i>steel wool</i>	<i>yes</i>
Copper (Cu)	<i>brass key</i>	<i>?</i>
Tin (Sn)	<i>tin can</i>	<i>yes</i>
Silver (Ag)	<i>silverware</i>	<i>?</i>
Nickel (Ni)	<i>post-1968 nickel coin</i>	<i>?</i>
Chromium (Cr)	<i>water faucet</i>	<i>no</i>

Nonmetal	Object	Malleability
Carbon (C)	<i>carbon paper</i>	<i>no</i>
Wood	<i>paper</i>	<i>no</i>
Plastic	<i>cassette case</i>	<i>no</i>

5. Which metals are malleable?

Most metals are malleable. The exceptions may be due to other alloys being mixed in with the metal being tested.

6. Were any nonmetals malleable? Explain.

No, there weren't any malleable nonmetals.

7. What generalization can you make about the malleability of metals and nonmetals?

Metals are generally malleable while nonmetals are not malleable.

8. What generalization can you make about the ductility of metals and nonmetals?

You could generalize that metals are ductile while nonmetals are not ductile.

9. Gold is very ductile. Gold is not used for making electrical power lines because it is a very rare metal. Suggest another reason why gold is not used for electrical power lines.

Gold is very dense and would make very heavy wires. Since it is also very ductile, the heavy power lines would cause the wire to stretch.

Section 3: Follow-up Activities

Extra Help

1. Fill in the blanks.

- Metals that are shiny are said to be *lustrous*.
- A shiny metal is *chromium*, which is plated over other metals.
- Aluminum* metal is a good conductor of heat and is used to make pots and pans.
- Copper* metal is a good conductor of electricity and is used for household wiring.
- Metals that are attracted to magnets are *iron*, nickel, or cobalt.
- Metals bend or are said to be *malleable*.

2. Match the terms on the right with the phrases on the left by placing the appropriate letter of the term in the blank beside the phrase.

 e

- i. easily tarnished

a. Cu

 d

- ii. light-bulb filament

b. ductile

 g

- iii. heavy metal used for car batteries

c. Al

 a, c, e

- iv. good conductor of electricity

d. tungsten

 i

- v. attracted to a magnet

e. Ag

<u> a </u>	vi. common metal used to conduct electricity in houses	f. malleable
<u> b </u>	vii. can be stretched into wire	g. Pb
<u> h </u>	viii. electricity can flow through	h. conduct
<u> f </u>	ix. can be bent	i. Fe

Enrichment

1. Discuss which metals and their properties would make them suitable for making cars. Use examples of the car parts involved.

Answers will vary but may include some or all of the following suggestions:

- *Steel sheet metal or galvanized steel are used for the body and frame of the car because the metal can easily be bent into the desired shape and corrosion is reduced.*
 - *Chromium plating on steel bumpers and body trim is used to prevent corrosion and produce an attractive and shiny appearance.*
2. Modern technology has begun to use the properties of metals to advance products even further. For example, some eyewear companies have begun to use certain metals with the influence of technology so that the metal eyewear frames retain the shape of the wearer.

- a. What property would metals need to have in order to produce a product such as this?

Metals would need to be malleable. Thus they could easily be bent into shape and then “memorize” that shape.

- b. How can doing this to eyewear be beneficial?

This could reduce the costs of getting eyewear fixed. It also could contribute to having eyewear with a better fit.

- c. Give a disadvantage of using technology on eyewear to this extent.

A disadvantage of doing this would be that manufacturers would have decreased sales. However, the cost of the eyewear might also increase. This would be beneficial to the producer but not to the consumer.

Section 4: Using Metals

Section 4 examines further the use of metals in society. Various examples of metal products and their uses and applications will be studied. Students will be given the opportunity to assess metal uses.

Section 4: Activity 1

1. Why do you think iron is used so extensively?

Iron is used extensively because it is abundant, fairly inexpensive, strong, and can easily be changed into a desired shape.

2. Using the five previous iron applications, identify to which application each of the following objects belongs. The first one is done for you.

- a. barbed wire fencing

C. Plated Steel

- b. dental and surgical instruments

D. Stainless Steel

- c. metal outdoor garbage can

C. Plated Steel

- d. drill bit

E. Special Steels

- e. metal scouring pad

A. Iron

- f. furnace heat duct

C. Plated Steel

- g. railroad tracks

A. Iron

- h. metal paint can

B. Coated Iron and Steel

- i. metal water trough for livestock

C. Plated Steel

- j. construction I-beams

B. Coated Iron and Steel

- k. car frame

A. Iron

- l. spring used to close a door

E. Special Steels

3. Suggest where copper is used in electric motors.

Copper is used in the armature coil of an electric motor.

4. Why is copper rather than iron used in plumbing?

Copper is used in plumbing because it is more resistant to corrosion than iron.

5. List some other common objects made from brass.

Some brass objects include decorative buttons, belt buckles, rings, hardware, door hinges and knobs, keys, beds, railings, coffee tables, shelving, figurines, and giftware.

6. Why do you think aluminum foil is sometimes called tinfoil in error?

Aluminum foil is sometimes called tinfoil because tinfoil was in existence and in use long before aluminum foil was.

7. Copper and aluminum are both good conductors of heat. Suggest why copper cooking utensils are not as common as those made of aluminum.

Copper utensils are not common because they are more expensive. Also, they are too soft, and thicker copper can react with certain foods.

8. What properties of aluminum make it a desirable metal for many applications?

Aluminum is a desirable metal for many applications for several reasons. It is very abundant, inexpensive, and one of the lightest metals. It is very ductile, corrosion resistant, and a good conductor of heat and electricity.

9. Suggest some common uses for galvanized sheet metal.

Galvanized sheet metal is used for eavestroughing, furnace heating ducts, and garbage cans.

10. Why is galvanized sheet metal generally not used to make cookie sheets and other bakeware?

Galvanized sheet metal is not used for bakeware because the melting point of zinc is fairly low (420°C). It is also more dense than aluminum due to the iron content.

11. Suggest why environmentalists demanded an end to the use of lead compounds in gasoline.

Environmentalists do not want lead compounds used in gasoline because they are poisonous. The lead compounds collect on streets from car exhaust and end up in rivers from rain and melting snow. Also, the water that people drink may come from polluted rivers containing these lead compounds.

12. Why are lead-based paints no longer allowed on pencils and baby furniture?

Lead-based paints on pencils and baby furniture were frequently ingested because of people biting on the objects; therefore, the poisonous lead was also ingested.

13. List some examples where lead solder is used.

Lead solder is used to make connections in electrical circuits and plumbing joints.

14. Why do you think iron, copper, and aluminum are used to make more objects than other metals?

Iron, copper, and aluminum are used to make more objects than any other metals because they are the most abundant metals found.

15. Nickel coins replaced silver coins in 1968. Why?

The price of silver was higher than the value of the coin.

Section 4: Activity 2

1. Suggest some problems you can see arising from the promotion of a metal recycling program.

The following are problems that could arise from promoting a metal recycling program:

- *Any new program of production will create new jobs but may destroy some jobs in the original production process. This adjustment is often met with resistance.*
- *Recycling sometimes produces new and undesirable wastes or products of little value. A good example is the current problem faced by society regarding the recycling of used tires.*
- *Recycling dangerous metals is often very expensive. An example is discarded batteries, both nonrechargeable, which contain mercury and other metals, and rechargeable, which may contain cadmium, lead, or other toxic metals.*
- *Many consumers still feel recycled products are inferior to products produced with original materials. These attitudes are often very hard to change.*

2. Do you think recycling waste metal is better than disposing of it in a landfill? Why?

Recycling waste metal is better for two main reasons:

- *Valuable mineral resources are conserved.*
- *Less metal in landfills means less chance of polluting water, land, and air.*

3. Do you think there are any metals which cannot be recycled?

There is only a tiny fraction of metals which cannot be recycled. This fraction is lost to corrosion or wear. If everyone ensured that no metal objects were disposed of in a landfill and that all objects were recycled regardless of cost, all metals could be recycled. In reality it is very difficult to recycle all metals.

4. Households and industries both produce dangerous metal wastes, but industrial sources produce more such wastes. Why do you think this is so?

Household metal wastes come from products that were used in the home and the products or containers must be disposed of once they have served their purpose. Industry operates on a larger scale and uses more toxic metals in reactions that are sometimes complex. A good example is the nuclear industry which uses and produces radioactive metals. Households use and produce very tiny amounts of radioactive wastes in applications such as smoke detectors.

5. What processes are involved in disposing of toxic metals?

Toxic metals and the products containing them should be sent to the Alberta Special Waste Treatment Centre or to a proper recycling plant. Lead from batteries can be recycled, but PCB-contaminated metals cannot be recycled.

Section 4: Follow-up Activities

Extra Help

1. Suggest which metals or metal alloys are used to make the following products.

- a. paper clips

galvanized or chrome-plated steel

- b. grain storage bin

galvanized steel

- c. TV antenna

aluminum

- d. household electrical wire

copper

- e. electric frying pan

aluminum

- f. furnace pipes or ducts

galvanized steel

- g. household hot and cold water pipes

copper

- h. galvanized sheet metal

iron and zinc

- i. barbed wire

galvanized steel

- j. car battery posts

lead

k. photographs

silver

l. farm machinery shed

galvanized steel

2. Place a T in front of the statements that are true and an F for those that are false. Correct any false statements.

 T a. Iron is the most widely used metal.

 T b. Lead and its compounds are poisonous.

 F c. Zinc has a very high melting point.

Zinc has a fairly low melting point.

 T d. Used oil cans can be recycled.

 F e. The Alberta Special Waste Treatment Centre in Swan Hills accepts used cars for disposal.

The Alberta Special Waste Treatment Centre accepts special wastes for disposal.

 F f. PCB-contaminated transformers are disposed of in municipal landfills.

PCB-contaminated transformers are not disposed of in municipal landfills.

 T g. Lead is a good conductor.

 T h. Copper is a good conductor of heat and electricity.

 T i. Tinfoil is the common name for aluminum foil.

 F j. Aluminum foil always has a silver shine.

Aluminum foil can either be shiny or dull.

Enrichment

1. Use outside resources to obtain information on gold panning. Discuss how gold is panned.

Gold panning for beginners requires only a few simple tools. You will need a spade (a pointed shovel), a gold pan (a special pan made of plastic or metal often with a set of ridges on the inside), a small plastic bottle used to pick up any gold flakes, and some gold-bearing gravel in a river.

Shovel some gravel into the pan. Dip the pan into the water and wash off the larger stones into the pan. Swirl the contents of the pan so that the more dense particles (the gold and black sand) settle to the bottom. Use your finger or the swirling action of the water to periodically remove the top layer of sand. This process is continued until you are left with a small amount of black sand and hopefully some gold. The gold is suctioned into the plastic container.

2. Research the Alberta Special Waste Treatment Centre in Swan Hills, Alberta to find out more about what it does.

The Alberta Special Waste Treatment Centre in Swan Hills is a modern, high-technology disposal plant. The basic principles involved in handling the special wastes are as follows.

- *Wastes are placed into steel barrels and transported to the centre by special trucks.*
- *None of the wastes or containers that enter the plant ever leave.*
- *The wastes are tested to determine the chemicals involved and then are treated accordingly.*
- *Some wastes are treated chemically.*
- *Some wastes are incinerated (burned at very high temperatures), and all waste gases are collected.*
- *The ashes are treated and processed with cement to produce inert blocks.*
- *The inert blocks are deposited in a specially lined covered pit. When the pit is full it is covered with plastic, clay, soil, and planted with grass.*
- *Treated liquids are injected into very deep wells.*
- *Materials which cannot be treated are stored in special containers and buildings.*
- *The entire centre is surrounded by drainage facilities which prevent any fluids from escaping to the surrounding environment.*

Key to the Assignment Booklet

Section 1 Assignment (30 marks)

- (8 marks) 1. Select any eight of the products listed in the chart shown on the following response page. For each product you choose, identify a suitable material that can be used to make it. Next, list two properties that make the material suitable for making that product. An example is shown.

Product	Material	Property
<i>window pane</i>	<i>glass</i>	<i>transparent, very hard, rigid</i>
<i>road culvert</i>	<i>metal</i>	<i>strong, hard, easily shaped, ductile</i>
<i>electrical wire</i>	<i>metal</i>	<i>conductor, ductile</i>
<i>compact disc</i>	<i>plastic</i>	<i>smooth, lightweight, moderately hard, flexible</i>
<i>streetlight pole</i>	<i>metal, wood</i>	<i>strong, hard, cheap, climbable</i>
<i>pop container</i>	<i>plastic, glass, metal (aluminum)</i>	<i>smooth, unbreakable, flexible, transparent</i>
<i>garden hose</i>	<i>plastic, rubber</i>	<i>smooth, unbreakable, flexible, soft, waterproof</i>
<i>T-shirt</i>	<i>fabric</i>	<i>soft, resilient, lightweight, washable</i>
<i>modern canoe</i>	<i>plastic (fibreglass), metal (aluminum)</i>	<i>lightweight, buoyant, strong, repairable, easily shaped</i>
<i>ketchup bottle</i>	<i>glass, plastic</i>	<i>smooth, semi-transparent</i>
<i>scissors</i>	<i>metal</i>	<i>strong, rigid, can be sharpened</i>
<i>house insulation</i>	<i>glass (fibreglass), plastic (styrofoam or polystyrene)</i>	<i>lightweight, fireproof, good heat insulator</i>

Product	Material	Property
toothbrush	<i>plastic</i>	<i>smooth, unbreakable, flexible, strong</i>

(4 marks) 2. Identify each of the following substances as either homogeneous or heterogeneous.

a. house plant

A house plant is homogeneous.

b. beef stew

Beef stew is heterogeneous.

c. vacuum cleaner

A vacuum cleaner is heterogeneous.

d. eyeglass lens

An eyeglass lens is homogeneous.

(4 marks) 3. Classify the following elements as metals or nonmetals.

Symbol/Name	Metal/Nonmetal
thallium	<i>metal</i>
Sc	<i>metal</i>
Xe	<i>nonmetal</i>
W	<i>metal</i>



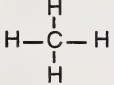
(4 marks) 4. Classify the following as elements or compounds.


Substance	Element/Compound
sugar	<i>compound</i>
sodium	<i>element</i>
tin	<i>element</i>
steel	<i>compound</i>

(4 marks) 5. Classify the following as mixtures or not a mixture.

Substance	Mixture/Not a Mixture
gold	<i>not a mixture</i>
coffee	<i>mixture</i>
soda pop	<i>mixture</i>
glass	<i>not a mixture</i>

(6 marks) 6. Complete the following table. An example is provided.

Name of Molecule	Molecular Structure	Kinds of Atoms	Number of Atoms
water		O H	O – 1 H – 2
sulphur dioxide		S O	S – 1 O – 2
methane natural gas		C H	C – 1 H – 4

Name of Molecule	Molecular Structure	Kinds of Atoms	Number of Atoms
ammonia		N H	$N - 1$ $H - 3$

Section 2 Assignment (26 marks)

- (6 marks) 1. Long ago, people were fascinated by the soft, red mineral cinnibar, HgS , because when cinnibar is gently heated in air, the silvery metal mercury is produced. The chemical change that occurs can be written as follows:

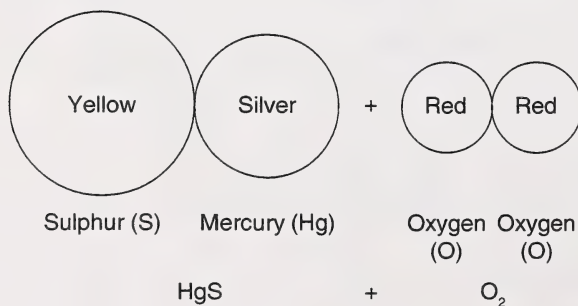


Answer the following questions by using the following sizes and colours to represent the atoms.



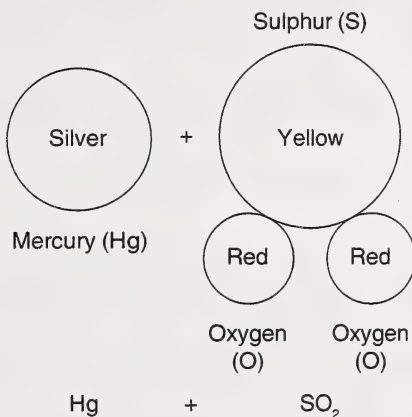
- a. On the response page, draw the models of the reactants, HgS and O_2 .

The reactants may be shown as follows:



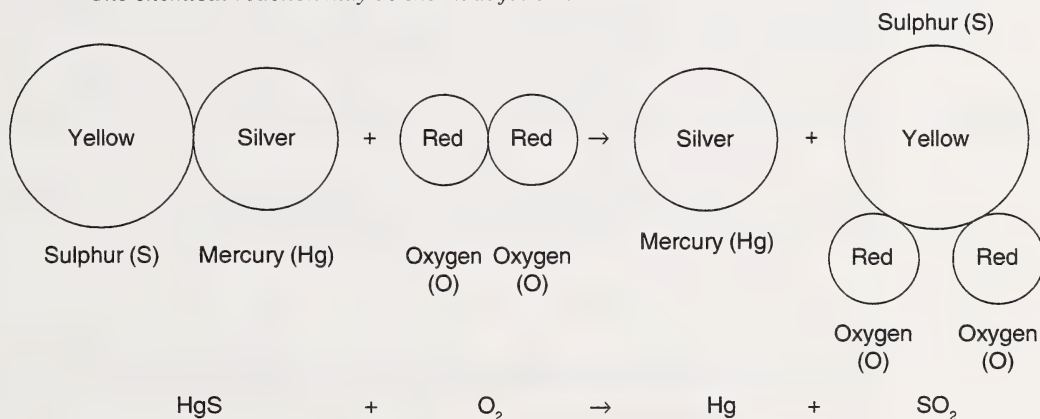
- b. On the response page, draw the models of the products, Hg and SO₂.

The products may be shown as follows:



- c. On the response page, draw the models of all reactants and products to represent the chemical reaction.

The chemical reaction may be shown as follows:



- d. What generalization can you make regarding the number and kind of each element in a chemical reaction?

The same kind and number of atoms are present in both the reactant and product molecules.

- (2 marks) 2. List four metals that can be found naturally as pure metals on Earth.

Metals that can be found as pure metals on Earth are copper, tin, silver, and gold.

- (4 marks) 3. List eight metals that were known to ancient people.

Metals that were known to ancient people are the following:

- copper
- tin
- iron
- silver
- gold
- antimony
- lead
- mercury

- (2 marks) 4. Explain why the metals known to ancient people were the first to be produced.

Metals known to ancient people were the first to be produced because these metals were easily removed from the mineral compounds by simple smelting methods.

- (2 marks) 5. Suggest two reasons why copper was probably the first metal to be smelted from its ore.

Many factors could have contributed to the discovery of the smelting of copper. Curiosity about the attractive green rocks in which copper is found probably encouraged collecting samples. At some time, the ores were either dropped or thrown into a fire resulting in copper being produced. The low smelting temperature and known properties of copper probably gave ancient people the idea that metals could be produced by using specific ores and heat.

- (2 marks) 6. Bronze is an alloy of copper and tin. This alloy was most likely discovered by accident. Explain how you think this accident may have occurred.

Bronze was probably discovered when people accidentally added naturally occurring samples of tin to melted copper. This resulted in a mixture that produced bronze.

- (2 marks) 7. Why did the Bronze Age occur before the Iron Age?

The metals that make bronze, copper and tin, require lower smelting temperatures than iron. Therefore, methods for working with bronze were developed before methods for smelting and working with iron were developed.

- (2 marks) 8. What is the most widely used alloy in the world? Why is this alloy so popular?

Steel or galvanized steel is the most widely used alloy in the world today. The use of steel is popular for many reasons. For example, steel is made from iron and carbon, both of which are abundant elements. Iron is fairly inexpensive because it is so abundant. Steel is more corrosion resistant than iron. Steel is a strong and hard material and can easily be shaped into many desired products. It can also be recycled when its original use is no longer required.

- (2 marks) 9. Why do you think car bodies, which come from areas that use salt on the roads during winter, rust more than car bodies from areas that do not use salt?

Salt in solution (salt and snow or ice) makes it easier for an electric charge to flow. This results in accelerated corrosion and rusting. Therefore, if there is more salt, there is probably more rust.

- (2 marks) 10. What two gases in the air are responsible for the corrosion in a copper object?

A copper penny will corrode when it is exposed to oxygen gas and hydrogen sulphide (rotten egg) gas.

Section 3 Assignment (20 marks)

Suppose that you are given a box containing eight unlabelled, thin metal strips. Each strip is made of a different metal – either iron, nickel, aluminum, silver, copper, lead, chromium, or zinc. Imagine that you must design and conduct an investigation in order to identify each metal. Answer the questions that follow. (Hint: Your investigation design should be similar to the investigations in your module booklet.)

- (2 marks) 1. What is the purpose of this investigation?

The purpose of this investigation is to identify unknown metal strips as being made of either iron, nickel, aluminum, silver, copper, lead, chromium, or zinc.

- (2 marks) 2. What materials do you need to conduct this investigation?

To conduct this investigation, you need the following materials:

- *unknown metal strips*
- *magnet*
- *conductivity metre or device*

- (4 marks) 3. List the steps to follow.

Answers will vary. The following steps should be carried out:

- *Assign each metal strip a different number.*
- *Describe the general appearance of each metal strip.*
- *Describe the colour of each strip.*
- *Test each strip for malleability.*
- *Test each metal strip for magnetism.*
- *Test each metal strip for conductivity.*
- *Record your findings in an observation table.*

- (8 marks) 4. List at least four main headings that would be appropriate in an observation table for this investigation.

Your observation table should include headings such as the following:

- *Sample*
- *Appearance*
- *Colour*
- *Ductility*
- *Magnetism*
- *Conductivity*

- (4 marks) 5. For each metal strip, list what identifying factor(s) would set it apart from the other metals.

Answers will vary. The following may serve as a general guide:

- *Iron can be identified because of its dull gray appearance and magnetic property.*
- *Nickel can be identified due to its shiny silver appearance and magnetic property.*
- *Aluminum can be identified due to its shiny silver appearance, malleability, and low density.*
- *Silver can be identified due to its shiny silver appearance and possibly some evidence of tarnish.*
- *Copper can be identified due to its reddish-brown colour.*
- *Lead can be identified because of its high density, dark gray or black colour, dullness, nonmagnetic property, and its ductility.*
- *Chromium can be identified due to its brilliant luster, malleability, and nonmagnetic property.*
- *Zinc can be identified due to its dull gray appearance and nonmagnetic property.*

Section 4 Assignment (24 marks)

- (2 marks) 1. Which two alloys are ideal for making carpentry or mechanical tools? Why?

Vanadium and chromium steels are two alloys that are ideal for making carpentry or mechanical tools because they are very strong and hard and resist corrosion.

- (3 marks) 2. Solder is an alloy used to join metals. Give three common examples where solder is used.

Solder is commonly used in plumbing to connect water pipes and fittings or prevent water leakage at the joints. It is also used to connect sections of galvanized metal used in eavestroughing or in sheet metal used to make food cans and other containers.

- (4 marks) 3. Explain four methods commonly used to prevent the corrosion of iron.

Methods used to prevent the corrosion of iron are the following:

- *changing it into a corrosion-resistant steel alloy containing iron and nickel or chromium*
- *dipping it into melted zinc to galvanize, that is, protect it with a thin layer of zinc*
- *plating it with corrosion-resistant chromium*
- *painting its surface*

- (4 marks) 4. Iron rebar is used for reinforcing concrete bridge supports, parkades, and building structures. Suggest two advantages and two disadvantages to using iron for this purpose.

Advantages to using iron rebar include the following:

- *It increases the strength of concrete by holding it together if cracks should develop.*
- *It prevents concrete supports from breaking apart and allowing the structure to collapse (particularly during earthquakes and other destructive forces to which the structures are exposed.)*

Disadvantages to using iron rebar include the following:

- *Iron corrodes easily.*
- *It is difficult to remove, making demolition of structures costly and time-consuming.*

- (4 marks) 5. List four properties of aluminum, and provide an example of a common object illustrating each property.

Aluminum is a good conductor of electricity and can be used for electrical wires and antennas. It is a good conductor of heat and is commonly used for cookware. Its light weight makes it ideal for aircraft and boats. Its corrosion resistance makes it ideal as a building material and for use as storage containers. Foil wrap and collapsible tubing make use of aluminum's softness, ductility, and malleability.

- (3 marks) 6. List three properties of lead and provide an example of a common object illustrating that property.

Lead is a dense metal that can be used for tire balance weights and ballast or counterweights. It is quite soft and ductile which makes it ideal for producing metal type. It melts at low temperatures and is used in making solder. Its coloured compounds are used as paint pigment. Its electrical reactions are used in making car batteries.

- (2 marks) 7. List two properties of silver, and provide an example of a common object illustrating that property.

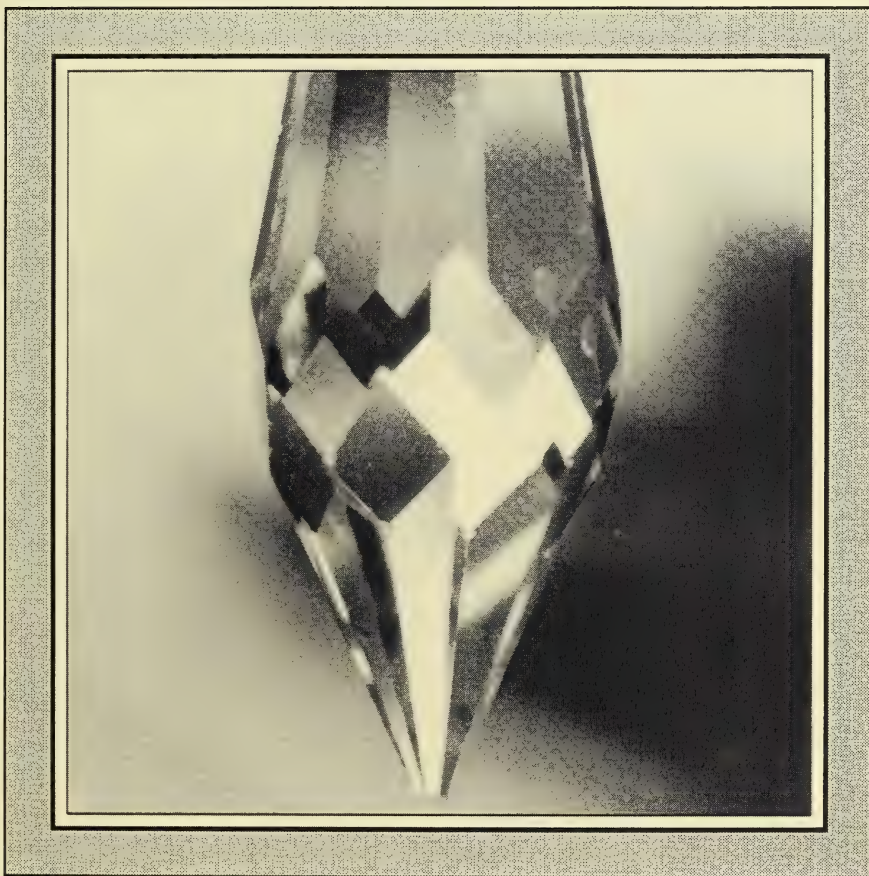
Silver has an attractive shiny appearance making it desirable for coins, jewellery, and silverware items. It is the best reflector of light, in the absence of tarnish, and is used to make mirrors. Its use in photography is based on its reactivity in the presence of light.

- (2 marks) 8. Used or unwanted iron products are commonly recycled. List two other metals that could be recycled.

Copper and its alloys can be recycled from used electrical conductors and plumbing fittings. Lead can be recycled from discarded batteries, balance weights, and other products. Aluminum can be recycled from used beverage containers and other products.

SCIENCE 24

Module 6: Exploring Nonmetals



Learning Facilitator's Manual



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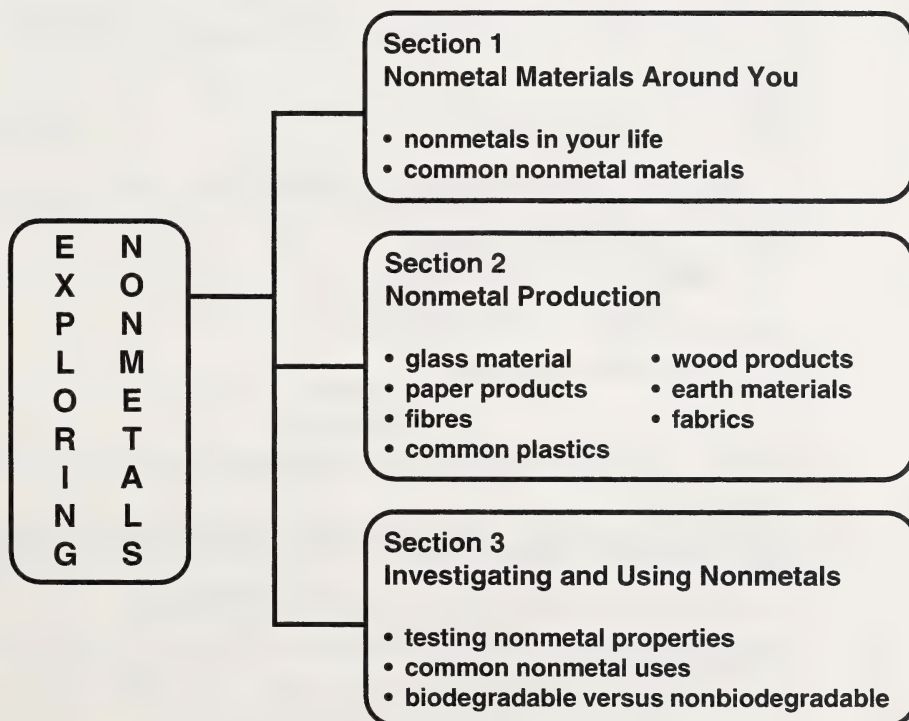
Module 6 – Exploring Nonmetals: Overview

The emphasis in this module is on nonmetal materials – their properties, their production, and their use in product applications. As technology continues to advance, new materials and products are being developed to meet the wants and needs of society.

Demands of the modern space program for construction of the space shuttle crafts and backups is an example of why technology develops and uses alloys, synthetic fibres, rubber, plastics, silicon, and other nonmetal materials. Modern society often enjoys numerous consumer products resulting from this spin-off space-age technology.

While technology attempts to achieve societal wants and needs, every material and product can be considered and evaluated in terms of its cost and benefit. For example many plastics are an extremely useful material in many of the products you enjoy as consumers. This is a benefit to society. When these materials and products are no longer wanted or needed, their disposal may have an impact on the environment. This is a cost to society.

As well, investigations through controlled experimentation are designed to develop an appreciation for the significant role that nonmetals play in modern society.



Materials and Equipment

The following is a list of materials and equipment necessary to complete the investigations and activities in Module 6.

Section 2: Activity 2

- a 20-cm stalk of celery
- 250 mL beaker or clear plastic cup
- red food colouring from your kitchen
- water
- sharp knife

Section 3: Activity 1

- box of facial tissue or shredded paper
- 2 L saucepan
- large mixing bowl
- blender or electric hand mixer
- sieve or strainer
- paper towels
- rolling pin
- discarded pantyhose
- coat hanger
- electric iron
- washing soda (sodium carbonate, Na_2CO_3)
- water
- two small squares of felt cloth about 30 cm × 30 cm
- four pieces of 10 cm × 10 cm cotton material
- staining materials such as the following:
 - oil or grease
 - coffee
 - ink
 - nail polish
 - blood from meat
 - fruit juice
- four liquids for removing the stain
 - cold water
 - soapy water
 - hot water
 - rubbing alcohol
- four glass or plastic containers (beakers or bowls)
- tongs or tweezers
- paper towel
- 1 cm × 1 cm pieces of fabrics such as cotton, wool, silk, nylon, polyester, acetate, or acrylic
- scissors
- binocular, low-power compound microscope, or magnifying glass
- four tin can lids or pieces of aluminum foil
- bunsen burner or lighter
- any fabric that can be tie-dyed such as an old T-shirt
- a coloured dye purchased in drugstore, craftstore, etc.

- two large bowls or plastic pails such as ice cream pails
- three marbles or polystyrene balls
- paper towels or an old towel
- string
- rubber bands
- rubber gloves
- plastic bowl
- 250 mL cornstarch
- mixing spoon
- food colour

Suggested Enrichment Activities

- Invite speakers from NAIT/SAIT to outline careers and programs available in plastics and other trades or material technologies. Field trips may be arranged to observe plastic injection molding technology.
- Arrange a field trip to Alberta Microelectronic Centre, Edmonton, to learn about applications such as thin film deposition, sputtering, micromachining, and metal-ceramic integrated chips.
- Arrange a field trip to The Laser Institute, Edmonton, to observe metal cutting, laser machinery, and the use of lasers and fibre optics.

Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	25 marks
Section 2 Assignment	45 marks
Section 3 Assignment	<u>30 marks</u>
TOTAL	100 marks

Section 1: Nonmetal Materials Around You

This section deals with common nonmetal materials from which products are made. Students are expected to appreciate the wide variety of nonmetal materials which includes plastics, natural and synthetic fibres, fabrics, ceramics, glass, and wood.

Students should also recognize that nonmetal materials may be beneficial or harmful to society if the material is not biodegradable.

Section 1: Activity 1

1. Telecommunication systems have been and continue to be developed using fibre optics technology. Can you suggest two nonmetal materials used in making optical fibres?

Two nonmetal materials used in making fibre optics are glass fibres and plastic jackets or coverings.

2. Synthetic rubber was systematically developed through the application of scientific processes to meet specific societal needs. Suggest why it replaced natural rubber.

Synthetic rubber replaced natural rubber as the demand was exceeding supply.

3. What problems do plastic products create as solid wastes?

One problem created by plastic product solid wastes is its disposal. Many plastics are not biodegradable.

4. Suggest some disposable plastic products that could be replaced with other materials to reduce solid waste problems.

Some disposable plastic products that could be replaced with other materials to reduce solid waste problems could include polystyrene cups, plastic bags, and plastic containers.

5. If plastic has created disposal problems, why has its use continued?

The use of plastic has continued because plastic is an extremely useful and convenient material in many of the products people use.

6. What are some benefits that society gets from plastics?

Some benefits that society gets from plastics include the following:

- *Plastic replaces metals in many products, for example, plastic is used in prosthetic devices and body implants.*
- *Cheaper products are available.*
- *Durable products are available.*

7. Give a benefit of using plastic rather than copper for plumbing.

One benefit of using plastic rather than copper for plumbing is its resistance to corrosion.

Section 1: Activity 2

1. List all the nonmetal materials you see in the photo.

Answers may vary, but some nonmetal materials found in the photo include the following:

- *fabric*
- *plastic*
- *soil*
- *rubber*

2. Identify common objects made from each of the following listed materials. Suggest one reason why the material is used to make the objects that it does.

Material	Objects	Reason
metal	<i>spoon nail barbed wire</i>	<i>hard, durable, strong</i>
plastic	<i>cups, cutlery grocery bag toothbrush</i>	<i>flexible, lightweight</i>
fibre	<i>fibreglass rope burlap</i>	<i>flexible, lightweight</i>
fabric	<i>drapes bed linen parachute</i>	<i>can be sewn, lightweight, resilient</i>
ceramics	<i>earthenware bathroom tile flower pot</i>	<i>strong, durable</i>
glass	<i>window light bulb bottles, jars</i>	<i>hard, smooth, transparent</i>
wood	<i>homes furniture boats</i>	<i>strong, can be cut and nailed</i>
paper	<i>cardboard box magazine receipt</i>	<i>can be printed</i>
rubber	<i>tire tube boots tubing</i>	<i>elastic</i>

Section 1: Follow-up Activities

Extra Help

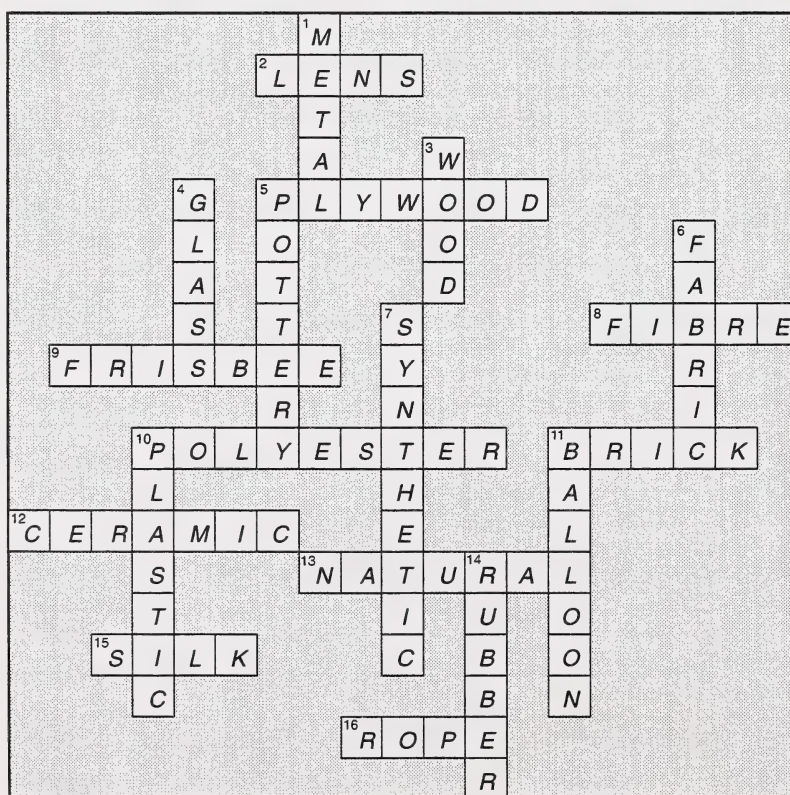
Complete the following nonmetal materials crossword.

Across Clues

2. polished grounded glass
5. layered wood
8. what silk is
9. plastic disc
10. blended with cotton
11. one of many in a fireplace
12. what some flower pots are made of
13. wool fibre
15. what some worms produce
16. braided sisal

Down Clues

1. antimony is one
3. tree product
4. optical lenses
5. baked clay
6. an example is denim
7. man-made
10. an example is a disposable spoon
11. inflatable rubber
14. tire



Enrichment

1. Make a list of twenty nonmetal materials. Decide whether each material is synthetic or made from natural material.

Answers may vary but could include:

Material	Egyptian Application	Modern Application
<i>metal</i>	<i>gold jewellery</i>	<i>aluminum alloy shuttlecraft</i>
<i>plastic</i>	<i>not available</i>	<i>computer housing</i>
<i>synthetic fibre</i>	<i>not available</i>	<i>fibre optics</i>
<i>synthetic fabric</i>	<i>not available</i>	<i>astronaut space suit</i>
<i>natural fibre</i>	<i>ropes used to move stone blocks</i>	<i>chemical treatment for mildew resistance</i>
<i>ceramic</i>	<i>clay pottery, water jars</i>	<i>space shuttle, insulating tiles</i>
<i>glass</i>	<i>coloured glass vessels</i>	<i>computer screens</i>
<i>wood</i>	<i>wood ships and boats</i>	<i>plywood concrete forms</i>
<i>paper</i>	<i>papyrus scrolls</i>	<i>sticky memo pads</i>
<i>rubber</i>	<i>not available</i>	<i>spacecraft o-ring connections</i>
<i>brick</i>	<i>claybrick ovens</i>	<i>launching pad</i>

2. Some of the nonmetal materials described in this section were available to the ancient Egyptians, and some nonmetal materials have only been recently developed. Research to find out whether the following materials are from ancient Egyptian times or modern times.

A list of nonmetal materials and their classification as synthetic (S) or natural (N) could include the following:

• <i>rayon</i>	– S	• <i>brick</i>	– N	• <i>orlon</i>	– S
• <i>silk</i>	– N	• <i>wool</i>	– N	• <i>plywood</i>	– N
• <i>cotton</i>	– N	• <i>stainless steel</i>	– N	• <i>glass</i>	– N
• <i>nylon</i>	– S	• <i>plastic</i>	– S	• <i>polyester</i>	– S
• <i>fibreglass</i>	– S	• <i>linen</i>	– N	• <i>ceramic</i>	– N
• <i>fibre optics</i>	– S	• <i>paper</i>	– N	• <i>cement</i>	– N
• <i>rubber</i>	– N/S	• <i>chalk</i>	– N		

Section 2: Nonmetal Production

This section is an introduction to nonmetal production. The wide variety of nonmetal materials and products, which includes glass, wood, paper, earth materials, natural and synthetic fibres, fabrics, and common plastics, are examined.

How nonmetal materials are obtained from their sources and some common nonmetal properties are also reviewed.

Section 2: Activity 1

1. List twelve common objects that are made from glass material.

Common objects that are made from glass material could include:

- eyeglasses
- headlights
- jars
- pop bottles
- windshields
- light bulbs
- camera
- beakers
- solar house
- street lights
- microscopes
- water glass, pitcher

2. Suggest three advantages in using glass to make the objects that you just identified.

Advantages in using glass to make the objects that you just identified could include the following:

- It is transparent.
- It can be reused repeatedly.
- It is smooth.
- It can be recycled.
- It can be sterilized.
- It is available at a low cost.

3. Suggest three disadvantages in using glass to make certain products.

Disadvantages in using glass to make certain products could include these facts

- It is breakable.
- It ices up in cold weather.
- It is hazardous when broken (unsafe).
- It is nonbiodegradable.
- It is heavier than plastic.
- It can act as a lens to start unwanted fires.

4. What do you think was kept in glass vessels by wealthy people during ancient times and the Middle Ages?

Glass vessels were probably used in the past to keep perfumes and spices.

5. Suggest two reasons why house windows were rarely used by early Canadian settlers.

The reasons why house windows were rarely used by early Canadian settlers are high costs, the use of native materials such as logs and stone, and scarcity of glass windows.

6. Suggest four factors that limit or prevent you from making your own glass windows.

Some factors that would limit or prevent you from making your own glass windows could include sand impurities, improper mixture of other materials required, extremely high temperatures required to melt the mixture, the difficulty of forming sheets by pouring molten glass, and the skill required for cutting and polishing it.

Section 2: Activity 2

1. List four common uses of wood.

Common uses of wood could include the following:

- telephone and electrical poles
- fences
- furniture
- pencils and rulers
- bridges
- boats
- railway ties
- farm buildings
- meat cutting board

2. a. List four common deciduous trees used to make wood products.

Common deciduous trees include the following:

- poplar
- maple
- elm
- oak
- birch
- walnut
- ash

- b. List four common coniferous trees used to make wood products.

Common coniferous trees include the following:

- spruce
- pine
- cedar
- fir
- hemlock
- redwood

3. What is the green material found in plants called?

The green material found in plants is called chlorophyll.

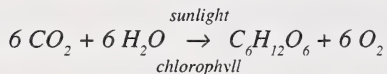
4. What other materials are needed for photosynthesis to occur in green plants besides chlorophyll and sunlight?

Besides chlorophyll and sunlight the other materials that green plants need for photosynthesis are carbon dioxide, CO_2 , and water, H_2O .

5. What materials do green plants produce during photosynthesis?

During photosynthesis green plants produce carbohydrates such as sugar, starch, and cellulose.

6. Using the word description, write the chemical change involved in photosynthesis in the form of an equation. Recall that the formula, $C_6H_{12}O_6$, is used to represent sugar in its simple form.



7. You may be aware that many people are concerned about the vast clearing of rain forests for agriculture. Why?

Vast depletion of rain forests reduces oxygen supplies needed by humans and animals. It increases the amount of carbon dioxide which contributes to the greenhouse effect.

8. What can the lumbering industry do once the trees are cut down to produce wood products?

Reforestation or planting of trees is usually practised by the lumbering industry to replace those trees that have been cut.

9. Describe the cross section of the celery stalk cut after you remove it from the coloured water.

Red circles should be evident on the bottom section of a cut celery stalk.

10. Observe and describe the strings along the length of the celery stalk once you separate them.

The strings along the length of the celery stalk should be coloured red.

11. Which part of a tree would probably contain vascular tubes?

The region directly under the bark or the sapwood contains vascular tubes.

12. Why does celery have a string-like structure?

Celery contains vascular tissue or bundles of xylem and phloem, which create a string-like structure.

13. Suggest three advantages in using plywood as a building material.

Advantages in using plywood are its strength, convenient size, ease of handling, quick coverage of a large building or area, and decreased building costs.

Section 2: Activity 3

1. Suggest what the word *polyester* could mean.

Polyester means many ester molecules.

2. Explain how you would draw a cellulose molecule using the model of the sugar molecule.

A cellulose molecule drawing requires hundreds or thousands of identical linked sugar molecules.

3. Besides storage boxes, suggest six other cardboard products.

Cardboard products besides storage boxes could include the following: milk and juice containers, textbook covers, poster paper, printed restaurant menus, corrugated packaging and shipping material for crated appliances, mailing tubes, and cylindrical concrete forms.

4. In what way is the cellulose molecule different from the sugar molecule?

A cellulose molecule is hundreds or thousands of sugar molecules linked together. It is only different from a sugar molecule in size.

5. Outline the steps in the industrial papermaking process.

The steps for the industrial papermaking process include the following:

- *mashing the wood*
- *making the pulp*
- *bleaching the pulp*
- *adding china clay and sizing*
- *removing water from fibres*
- *pressing the pulp into continuous sheets of smooth paper by rollers*
- *drying the paper and putting it into huge rolls*

Section 2: Activity 4

1. Concrete is a widely used material. Suggest six structures in which concrete is used.

Structures in which concrete is used could include the following:

- *building blocks*
- *basements*
- *driveways*
- *sidewalks*
- *patios*
- *bridge supports*

2. When ancient civilizations made bricks, they baked them in the sun rather than kilns. What problems could be encountered by using this method?

Bricks that are baked in the sun rather than a kiln are not as weather-resistant and could fall apart from rain and other elements.

3. Suggest four ancient civilizations that extensively used brick as a building material.

Some ancient civilizations that used bricks were the Greeks, Romans, Egyptians, Incas, and Mayas. They built roads (Apian Way), temples, pyramids, colosseums, and other buildings.

4. How are bricks held together to build structures?

Bricks are held together with mortar which is a cement mixture.

5. Suggest four common ceramic products.

Common ceramic products include vases, figurines, statues, pots, kilns, bake ovens, plaques, jewellery items, and tiles.

6. Why are power transmission lines connected to ceramic insulators?

Power transmission lines are connected to ceramic insulators to prevent accidental electrocutions.

7. What cools the water inside a ceramic container?

Because ceramic is porous, water seeps to the outside of the container. Here, evaporation takes place. The process of evaporation needs heat. It is a cooling process when heat is removed from the water inside the container.

8. During construction, ceramic weeping tile is installed around the basement of homes and is connected to a sewer line. Can you suggest why weeping tile is used?

Weeping tile collects excess rainwater and prevents it from entering the basement.

9. Some people travelling in hot weather put a canvas bag of water on the outside of a car. How is the water inside the bag cooled?

Evaporation of water on the outside of the bag increases in a moving car causing the water inside the canvas bag to cool since evaporation is a cooling process.

10. Why does blowing on a spoonful of hot soup or hot chocolate cool it?

The wind you create speeds up evaporation of the hot liquid. Evaporation is a cooling process.

11. Suggest two common porcelain products.

Common porcelain products include electrical insulators, light receptacles, dolls, figurines, sinks, bathtubs, toilet bowls, and fine china.

Section 2: Activity 5

1. In what way is fibreglass similar to fabric?

Both fibreglass and fabrics are made from individual fibres that are intertwined.

2. In what way is fibreglass different from fabric?

Fibreglass is made from molten rock and fabric is made from other materials.

3. Suggest why different coloured plastic jackets might be used to cover each individual optical fibre inside a cable.

Each cable is made with several individual fibre optics inside it. A different coloured plastic jacket around each fibre optics would identify which fibre is inside which cable. Use of colour keeps track of which fibre is used for various communication signals.

4. If a break occurs in an optical fibre, it is spliced under a microscope with an electric spark. Suggest why this technique might be used.

Since fibre optics is a glass material, it needs to be melted by an electric spark. A microscope is used because it magnifies the hair-like fibre so that the splice can be accurately made.

Section 2: Activity 6

1. How are fibre materials classified?

Fibre materials are classified as natural or synthetic.

2. For each statement select the most probable reason that explains why the material was developed. Place the letter(s) of the reason(s) in the space provided beside the statement.

- a. B the development of synthetic rubber
- b. D the development of Teflon
- c. A, B the use of synthetic fabrics in clothing
- d. A the use of nylon instead of silk
- e. A the use of plastic pop bottles instead of glass
- f. C the use of fibreglass insulation in homes instead of wood shavings

3. Indicate whether the following products are made of natural or synthetic materials. Use N for natural and S for synthetic.

- | | |
|-------------------------------|----------------------------------|
| a. <u> S </u> rayon jacket | f. <u> S </u> plastic bottles |
| b. <u> S </u> orlon sweater | g. <u> N </u> plywood |
| c. <u> N </u> wool socks | h. <u> S </u> fibreglass canoe |
| d. <u> N </u> cotton pants | i. <u> S </u> automobile tires |
| e. <u> N </u> glass window | j. <u> N </u> iron hammer |

4. Why is paper not considered a synthetic material?

Paper is not considered a synthetic material because it is made from the natural fibre cellulose.

5. Suggest some reasons why synthetic fibres are replacing natural fibres on such a large scale?

Reasons why synthetic fibres are replacing natural fibres may include their strength, durability, resistance to shrinkage and wrinkling, ease of washing and dyeing, lower cost, and better availability.

6. What is one of the resources used to make synthetic fibres?

One resource for making synthetic fibres is sand. Glass made from molten sand can be made into fibreglass and fibre optics.

7. Indicate whether the article is made of natural fibre (N), synthetic fibre (S), or a mixture of both (B) kinds of fibres in the following table. The first one is done as an example for you.

Fabrics in the articles could vary but may include the following:

Article	Fabrics in Article	Type of Fabrics
T-shirt	cotton, polyester	B
sweater	<i>cotton, wool, polyester, or mixture</i>	<i>N, S, B</i>
towel	<i>polyester and cotton</i>	<i>B</i>
shirt	<i>polyester or nylon</i>	<i>S</i>
summer jacket	<i>wool</i>	<i>N</i>
sweatshirt or sportswear	<i>polyester and cotton</i>	<i>B</i>
bathing suit	<i>polyester and cotton</i>	<i>B</i>
socks	<i>nylon, wool, cotton, or mixture</i>	<i>N, S, B</i>
a pair of pants or blue jeans	<i>wool, cotton, polyester or mixture</i>	<i>N, S, B</i>
winter jacket	<i>nylon or polyester with synthetic or natural fill</i>	<i>N, S, B</i>

8. Why are natural and synthetic fibre blends beneficial?

If the properties required by a product do not occur in one fabric, then the needs of the product might be met by mixing fibres. This provides properties of each fibre to the new material.

9. Why isn't cotton grown in Alberta?

Cotton needs a tropical climate. The climate in Alberta is too cold for growing cotton.

10. a. Suggest some advantages of using cotton cloth.

Advantages of cotton clothing include the following:

- cool and lightweight
- wide variety of weights and textures
- dyes easily
- can be bleached

- b. Suggest some disadvantages of using cotton cloth.

Disadvantages of cotton clothing include the following:

- creases readily
- subject to mildew and rot
- fades

11. Name some synthetic fibres.

Synthetic fibres could include rayon, nylon, acrilan, orlon, or polyester.

12. Which fabrics do you think tend to produce static cling?

Some fabrics which tend to produce static cling could include nylon, polyesters, and orlon.

13. What are cellulose fibres made of?

Cellulose fibres are made of chains of sugar molecules.

14. What is the industrial source of cellulose fibres?

Cellulose is obtained from softwoods such as conifers.

15. Nylon and rayon are both synthetic materials but are considerably different. Explain the difference.

Nylon is produced from synthetic fibres. Rayon is a synthetic that is produced from natural fibres.

16. In the process of making a fibre, a spinneret is needed. Explain the function of a spinneret in making rayon.

A spinneret, which is a metal plate with holes in it, creates thin streams of a solution that solidifies as fibres.

17. What four properties make rayon a suitable material for making clothing?

Rayon is a suitable material for making clothing because it has the following characteristics:

- strong
- easily dyed
- smooth, shiny
- feels like silk
- static free
- absorbent
- doesn't fade

18. List four articles that are made from nylon.

Nylon is a multipurpose fibre used to make ropes, jackets, carpeting, upholstery fabrics, shoes, tents, tarpaulins, tote bags, and luggage.

19. What advantage would there be in making nylon and other synthetic fibres in Alberta?

Alberta has abundant supplies of petrochemicals and feedstock needed to make nylon and other synthetic fibres.

20. a. What are the advantages of using nylon as a material for clothing?

The following are the advantages in using nylon. Nylon

- is resilient
- is strong
- is resistant to mildew and insect damage
- washes easily
- dries quickly
- blends with other fibres

- b. What are the disadvantages of using nylon as a clothing material?

These are disadvantages to using nylon:

- tends to yellow
- accumulates static electrical charges
- is a hot rather than cool fabric like cotton
- shags easily

Section 2: Activity 7

1. What conclusions might you come to if you were unsuccessful in gluing a broken plastic object?

You might conclude that there are many different kinds of plastics, that the glue was not designed for the particular plastic, or that plastic cannot be repaired with glue.

2. Define the following words.

- a. organic

Organic refers to molecules containing carbon.

- b. polymer

A polymer is a long chain of molecules containing many monomers.

- c. petrochemical

Petrochemical refers to a chemical derived from petroleum or natural gas.

- d. feedstock

Feedstock is a petrochemical raw material used to make synthetics and other products.

3. Name three resources found in Alberta that can be used to make plastics.

Three Alberta resources that can be used to make plastics are coal, oil, and natural gas.

4. Write the name of the plastic described in the statements.

- | | |
|--------------------------|--|
| a. <u>fluoroplastics</u> | a cookware coating that feels waxy |
| b. <u>silicons</u> | good weathering property; used for window glazing |
| c. <u>phenolics</u> | made into pot and pan handles due to its high heat resistance |
| d. <u>silicones</u> | used to make molds for picture frames |
| e. <u>melamines</u> | used to make counter and tabletops |
| f. <u>epoxy</u> | adhesive used to bond wood |
| g. <u>melamines</u> | thermosetting material made into dinnerware |
| h. <u>polyethylene</u> | soft, flexible, waxy-feeling plastic used to produce food containers, toys, grocery and garbage bags |
| i. <u>acrylics</u> | made into taillight lenses |
| j. <u>ABS</u> | made into luggage and instrument panels |

5. What are some uses for pipes and tubing made by extrusion?

Some uses for pipes and tubing made by extrusion could include the following: water, sewer, and gas pipes; plumbing fittings; connectors; and hoses.

6. Why are metals coated with plastic?

Metals are coated with plastic to prevent corrosion.

7. Why must the plastic be heated when placed into a mold?

Plastic becomes semi-solid when heated and can be poured into a mold to assume the mold's shape.

8. Fibreglass resin, hardener, and fibreglass fabric are used to repair minor dents and creases in auto bodies. What advantage does this method have?

Repairing minor dents and creases in auto bodies with fibreglass resin, hardener, and fibreglass fabric is effective, faster, and cheaper than repairing or replacing metal. It also will not rust.

9. Polyethylene, also called polythene, is widely used as a vapour barrier sheeting in building construction. Why?

Polyethylene is widely used as a vapour barrier sheeting in building construction to enclose the structure from rain and snow, especially during winter construction. It is also used as a vapour barrier between the insulation and plasterboard in homes.

10. Give other uses for polyethylene sheets.

Polyethylene sheets could be used as a vapour barrier in walls and floors of buildings and as a tarpaulin over haystacks, lumber, vehicles, machinery, and other outdoor items.

11. In what two ways does an ethene monomer molecule differ from an ethane monomer molecule?

An ethene monomer molecule differs from an ethane monomer molecule in that it has a double bond between the carbon atoms and has two fewer hydrogen atoms.

12. Why are polyethylene pellets and products produced in Alberta?

Alberta has an abundant supply of natural gas needed to produce polyethylene.

Section 2: Follow-up Activities

Extra Help

1. Fill in the blanks.

- a. Glass can discolour or change its hardness if sand contains *impurities*.
- b. Rollers used to flatten melted glass are lined with *asbestos*.
- c. When safety glass is made, the material sandwiched between the sheets of glass is *plastic*.
- d. Trees producing hardwood are *deciduous* trees.
- e. Trees producing softwood are *coniferous* trees.
- f. The raw materials needed for photosynthesis are *water* and *carbon dioxide*.
- g. The age of a tree can be determined by counting its *rings*.
- h. Because cellulose contains many molecules, it is a *polymer*.
- i. Chlorine or hydrogen peroxide is used to *bleach* paper.
- j. Concrete is a mixture of *cement*, *water*, and *aggregate*.
- k. Bricks are made from *clay* and baked in a *kiln*.
- l. Porcelain is made from a white clay called *kaolin*.
- m. A fibre optics instrument used in medicine for internal examination is called an *endoscope*.
- n. The first synthetic fibre ever made is called *rayon*.
- o. The word *poly* means *many*.
- p. Small repeating molecules that make plastic molecules are called *monomers*.
- q. Material that may be repeatedly softened when heated and hardened when cooled is *thermoplastic*.
- r. A gas that is an important monomer for polyethylene is called *ethane*.
- s. Whether plastic is thermoplastic or thermosetting is determined by *molecule arrangement*.
- t. A plastic that is resistant to heat and is used to make handles for pots and pans is *acrylic*.

2. Determine if the following statements are true or false. Write a T to indicate true and F to indicate false. Rewrite the false statements to make them true.

- T a. Polyethene is a polymer made from natural gas.
- T b. Both natural and synthetic materials require processing.
- T c. Cotton is spun into yarn and then woven into fabric.
- T d. Sizing and china clay are additives in the papermaking process.
- F e. A spinneret is used to mix solutions when making synthetic fibres.

A spinneret creates thin streams or fibres of synthetics.

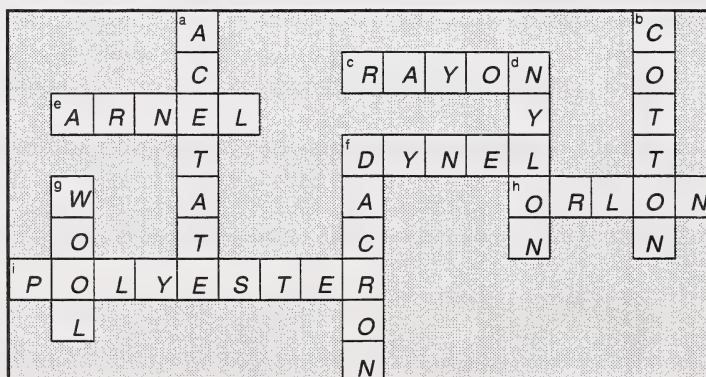
3. Using the following clues, complete the crossword puzzle on synthetic and natural fibres.

Across

- c. artificial silk, made from cellulose
e. shiny, strong, dyes easily
f. washes easily, warm, resists mildew
h. dries rapidly, bulky
i. strong, resists wrinkling, used extensively

Down

- a. dyes easily, shiny, strong
b. cool, soft, dyes easily
d. stockings made with this fibre
f. dries rapidly, strong, resists wrinkling
g. warm, resists wrinkling, dyes easily



Enrichment

1. Write a report on why fibre optics are replacing copper wire to transmit communication signals.

Answers could vary but could include some or all of the following reasons:

- *Fibre optics increase the distance in which repeater stations are placed – every seventy kilometres for telephone signals or about every one kilometre for TV cables with copper wire. As distance increases, communication signals become weaker and must be boosted with repeaters.*
- *Fibre optics increase the potential band width which determines the amount of information that can be transmitted.*
- *Fibre optics are smaller, lightweight, and they can fit in tighter spaces than copper wire.*
- *Fibre optics reduce security risks because communication signals such as those involving computers are more difficult to tap into.*
- *Fibre optics do not pick up electrical interference in areas of high electrical activity as does copper; therefore signals are clearer.*
- *Lightning does not strike the nonmetal fibre optics.*

2. Read the following sentences on the interaction between science, technology, and society. Answer the questions that follow.

- Society, science, and technology are three factors that interact. They cause products and materials to change with time.
- The relationship is complex. For example, scientists discovered a new semiconducting substance.
- Technologists developed a method for producing the material and developed the microchip.
- Society demanded quicker, more inexpensive, and more reliable computer systems that used less energy. An application for microchips was found.
- Science asks *why*. Technology asks *how*, and society asks *should it be done*.

Complete the following statements by suggesting how either science, technology, or society issues are involved. An example is given.

Science asks: Why is ceramic material a suitable material for making toilet bowls?

Technology asks: How can toilet bowls be made efficiently and economically from ceramic materials?

Society asks: Should labour or machines or ceramic materials be used to make toilet bowls?

Answers may vary but could include the following ideas:

- a. **Science asks:** Why does light travel through a glass fibre from one end to the other even if the glass fibre is bent?

Technology asks: *How could you find a better material for light to pass through?*

Society asks: *Should materials that are difficult to recycle be continued to be used?*

- b. **Science asks:** *Why do coniferous trees make the best cellulose fibre to produce paper?*

Technology asks: *How could you make paper from other cellulose sources besides trees?*

Society asks: *Could wood resources be depleted to make unnecessary paper products?*

- c. **Science asks:** *Why do certain molecules polymerize and why do polymers have certain properties?*

Technology asks: *How could plastics be made at a lower cost, be more efficient, or have expanded application?*

Society asks: *Should plastics be made from nonrenewable petrochemical resources if the products are difficult to recycle?*

- d. **Science asks:** *Why are properties of synthetic fibres so varied?*

Technology asks: *How could properties of synthetic fibres be improved or new applications be found for greater use?*

Society asks: *Should more money be spent on the research and development of natural and synthetic fibres?*

Section 3: Investigating and Using Nonmetals

In this section students will use selected nonmetals to investigate some nonmetal properties. They will continue to develop scientific inquiry skills through investigation of objects made from nonmetal materials.

Students will evaluate some nonmetal material applications or uses as well as evaluate biodegradable and nonbiodegradable solid waste management.

Section 3: Activity 1

1. What problems could you encounter with testing glass properties?

Testing glass properties may necessitate using high temperatures. There is also a danger from breakage.

2. What problems could you encounter with testing wood properties?

Testing wood properties may require a large collection of softwood and hardwood samples which could be a problem.

3. What problems could you encounter with testing fibre and plastic properties?

Testing of fibre and plastic properties may need sophisticated laboratory equipment, devices, and instruments not readily available in a school laboratory.

4. Besides not having access to advanced laboratory equipment, devices, and instruments, what other limitations would you encounter in conducting some of the nonmetal properties testing?

Limitations that you would encounter in conducting some of the testing listed could include using certain procedures with which you are unfamiliar.

5. Write on your paper with a pencil, ballpoint pen, or felt tip pen.

- a. Which writing instrument works best? Why?

Probably a ballpoint pen works best due to the dry ink which is not absorbed by the porous paper.

- b. Which of the three writing instruments is the least effective? Why?

The felt tip pen is the worst due to having a wet ink which is absorbed by the porous paper.

6. Record your results by completing the following table. Record treatment success as (X-no ✓-yes).

Stain	Cold Water	Hot Water	Hot Soapy Water	Rubbing Alcohol
blood	✓	X	X	X
ink	X	X	X	✓
grease	X	X	✓	✓
coffee	✓	✓	X	X
juice	✓	✓	✓	X
nail polish	X	X	X	X

7. Suggest a suitable title for your table.

A suitable title could be Removing Stains from Cotton.

8. Which stains were removed

- a. by cold water?

Blood, coffee, and fruit juice were removed in cold water.

- b. by hot water?

Coffee and fruit juice were removed in hot water.

- c. by hot soapy water?

Oil or grease and fruit juice were removed in hot soapy water.

- d. by rubbing alcohol?

Grease and ink were removed in rubbing alcohol.

9. Which stains were not removed by any of the treatments?

Nail polish was not removed by any of these methods.

10. What is a stain?

A stain is similar to a dye in that it is a colouring that penetrates fabric fibres.

11. Predict if the same tests would work with nylon.

The same tests would probably work with nylon.

12. Suggest why it is best to treat stains promptly.

Stains would not have a chance to penetrate the fibres if they are treated promptly.

13. Suggest why fabrics should be tested for colourfastness before treating a stain.

Fabrics should be tested for colourfastness because treatment methods could remove or change the colour.

14. Name three properties common to

- a. wool and silk fabrics

Wool and silk fabrics should not melt on a metal lid, they should burn quickly, they should turn black when burned, and they should bend.

- b. cotton and silk fabrics

Cotton and silk fabrics should not melt on a metal lid, the fabrics should burn slowly, they should turn a light colour when burned, and they should bend.

- c. polyester fabrics

Polyester fabrics should melt on a metal lid, the fabrics should burn slowly, and they should turn a light colour when burned.

- d. nylon fabrics

Nylon fabrics should melt on a metal lid, the fabrics should burn slowly, and they should turn a dark colour when burned.

- e. acrylic fabrics

Acrylic fabrics should melt on a metal lid and the fabrics should burn slowly. Dynel will snap and orlon will bend.

15. What two properties are common to acetate fabrics?

Acetate fabrics should melt on a metal lid and the fabric should burn quickly.

16. Sketch a portion of the most interesting or pleasing pattern that you obtained in your fabric.

Since different methods were used to achieve tie-dyeing, each sketch will be a unique work of art.

17. How does tie-dyeing a fabric produce patterned effects?

Tie-dyeing a fabric produces patterned effects from the uneven absorption of dye due to tight and loose areas exposed to the dye.

18. What is the difference between tie-dyeing and batik?

In tie-dyeing, the entire surface can be dyed, whereas in batik certain areas resist dyes.

19. a. How does the mixture react when your fingers or hand are placed into it quickly?

The mixture tends to resist the pressure of your fingers or hand when they are placed into it quickly.

- b. How does the mixture react when your fingers or hand are placed into it slowly?

The mixture changes shape when your fingers or hand are placed into it slowly.

20. How does the mixture react when you hit its surface?

The mixture tends to resist the pressure of your hand or fist when you hit its surface.

21. How do you know that the mixture is a polymer?

The mixture is a polymer because the starch from which it is made is a polymer.

22. In what way does the mixture behave as synthetic rubber?

The mixture has an elasticity similar to synthetic rubber.

23. Suggest what the addition of food colour could illustrate or simulate.

Adding colour illustrates that fabrics, wood, paper, ceramics, leather, plastics, and other materials are commonly coloured or dyed.

Section 3: Activity 2

1. Suggest from what materials calculators or portable radios are made.

Calculators or portable radios could be made from plastic, metal, and ceramic materials.

2. Suggest why paper products are so widely used.

Paper products are widely used because they are inexpensive, they have a wide assortment of textures and thicknesses, and their raw materials are abundant.

3. What industry uses the most paper?

The newspaper industry uses the most paper.

4. What property of chromium-plating is used to produce shiny paper?

Chromium-plating transfers its very shiny property to the surface of the paper. Shiny photographs were produced by the same method at one time.

5. Suggest other objects in which glass lenses are used.

Other objects that use glass lenses are eye glasses, binoculars, and magnifying glasses.

6. What are some uses of curved glass?

Some uses of curved glass include magnification, lenses for various instruments, and the starting of fires.

7. What is a likely source for curved glass that can start forest fires?

Empty bottles are one likely source of curved glass which can start forest fires.

8. What is the name of the glass used to make labware such as beakers?

Glass used to make labware is called Pyrex.

9. If infrared radiation from the sun passes through glass, why does a greenhouse or car with its windows closed get hot?

A greenhouse or car with its windows closed gets hot because glass allows infrared radiation from the sun to enter but not leave it. The air molecules trapped inside absorb the radiation as heat.

10. Suggest three uses for coloured glass.

Uses for coloured glass could include traffic lights, signs, stained glass windows, lamp shades, jewellery, and other art forms.

11. Which oxides are used to produce the following colours?

Oxides that produce the following colours are

red:	gold or selenium	brown:	iron
violet:	manganese	yellow:	uranium or silver
blue:	cobalt		

12. During winter, birds fluff their feathers. How does this keep them warm?

When birds fluff their feathers during winter, they keep warm because of the insulating dead air spaces between their feathers.

13. Inuit wear loose clothing. How does this keep them warm?

Inuit keep warm by wearing loose clothing. Body heat is trapped by the insulating dead air spaces between the body and clothing.

14. Why is a woollen sweater warmer than a leather jacket?

A woollen sweater is warmer than a leather jacket because of the insulating dead air spaces in the knit.

15. When your body sweats, evaporation keeps you cool. Would it make sense to wear woollen clothing during summer? Explain.

It would not make sense to wear woollen clothing during summer because wool insulates body heat. It is not water-resistant, it absorbs sweat, and it prevents evaporation of sweat which is a cooling process.

On the other hand, people in hot, arid areas purposely wear layers of woollens for protection.

16. List some common items made from wool.

Common items made from wool would include the following:

- | | |
|------------|-----------|
| • sweaters | • scarves |
| • blankets | • mittens |
| • socks | • afghans |
| • skirts | • yarn |

17. What material is used to make lightweight pup tents? Why?

Nylon is used to make lightweight pup tents. It is water-resistant.

18. Why is nylon used in making sleeping bags and ski jackets?

Nylon is not water absorbent and retains body heat.

19. Suggest three reasons why you would select synthetic fibres as insulation fillers in a jacket or ski suit.

Synthetic fibres used as insulation fillers in a jacket or ski suit are warm, lightweight, and comfortable.

20. What fabrics can be made from cotton fibres?

Fabrics that can be made from cotton fibres are denim and canvas.

21. What are the advantages of using precast concrete in building construction rather than pouring concrete into forms?

Precast concrete speeds up time of construction. It does not require the construction of forms needed for pouring of concrete and relies on prefabricated sections which are already made to specifications and tested.

22. What is concrete cribbing and where is it used?

Concrete cribbing is a concrete structure used for intake of water, piers, or storage enclosures such as silos.

23. What gives precast concrete its strength?

Precast concrete is strengthened with iron rebar or wire mesh.

24. What are the advantages of using bricks to build schools, hospitals, and other large buildings?

Using bricks to build schools, hospitals, and other large buildings could prolong the life of the institution, increase its fireproof property, and allow for easier future expansion or modification.

25. Why are ceramic tiles used inside showers and on kitchen or bathroom counter backsplash areas?

Ceramic tiles are used in areas such as showers and kitchen and bathroom counters to prevent damage to walls from water backsplash.

26. What is an extrusion plastic?

An extrusion plastic is one that is made by forcing the plastic material through an opening in a continuous manner.

27. Discuss whether condiments and salad dressings should continue to be sold in convenient and disposable squeeze bottles or whether only refillable bottles should be used.

Answers may vary. Consumers will want the prices as low as possible and the product inside easily gotten out. Environmentalists will want to use reusables to reduce waste.

28. a. Suggest why plastic should be used for garbage and grocery bags.

Plastic garbage bags and grocery bags prevent unpleasant odours from escaping. They are sanitary.

- b. Suggest why plastic should not be used for garbage and grocery bags.

Plastic does not decompose. Nonrenewable resources are needed to make plastic.

29. Why is polyethylene plastic used for labware?

Polyethylene plastic is used for labware because it is tough, unbreakable, transparent, and chemical-resistant.

30. Why are electrical tools and wires commonly covered with a plastic coating?

Electrical wiring tools are commonly covered with plastic to prevent electrical shock. Wire is coated with plastic by extrusion to prevent electrical fires and shock.

Section 3: Activity 3

1. a. Suggest why motor oil is now packaged in plastic containers rather than the former metal ones.

Rectangular-shaped plastic containers take less storage space than round metal containers. They are easier to package, store, and display, as well as being more convenient to open and pour.

- b. What problem do the empty plastic containers create that metal ones do not?

Metal can be recycled. Plastic adds to the waste disposal problem.

2. Why do decomposers require enzymes?

Decomposers need enzymes in order to break the bonds between molecules and atoms.

3. What three things are needed in order for garbage to decompose?

In order for garbage to decompose it must be biodegradable. Decomposers and specific enzymes must also be present.

4. What happens when garbage is decomposed?

When garbage is decomposed it is broken up into atoms and molecules which can be reused.

5. Suggest why many synthetic substances such as plastics are nonbiodegradable.

Scientists are searching for organisms in the environment that have the enzymes necessary to break down or digest plastics. Perhaps the problem will be solved in the future.

6. What would happen to the environment if there were no decomposers?

If there were no decomposers, the Earth would be a gigantic garbage dump by now. Materials would accumulate and would not break down; therefore the atoms in these materials could not be recycled.

7. What happens to atoms when they are released from molecules?

Atoms are reused or recycled.

8. Often new synthetic materials replace natural ones. What are potential problems with this?

Some synthetic materials may not be biodegradable.

9. Suggest several plastic products or uses which might be banned or discontinued in favour of other materials.

Plastic products or uses that should be banned or discontinued in favour of other materials could include polystyrene cups, plastic grocery bags, plastic hamburger boxes at fast food outlets, plastic milk pouches, and plastic cutlery.

Section 3: Follow-up Activities

Extra Help

1. The following list of properties may or may not be present in certain materials. For each of the products given, write the letters of the properties that are present in the materials from which the product is made.

A. hard	D. elastic
B. tensile	E. conductive
C. flexible	F. transparent

- | | |
|-------------------------------|---------------------------------|
| a. <u>C, D</u> rubber tires | f. <u>B</u> polystyrene cup |
| b. <u>A, F</u> house windows | g. <u>B, C</u> denim blue jeans |
| c. <u>C</u> toy doll | h. <u>C</u> cardboard box |
| d. <u>C</u> garden hose | i. <u>A, B</u> brick planter |
| e. <u>A, B, E</u> steel cable | j. <u>A, B</u> cement sidewalk |
2. Fill in the blanks.
- The method used to remove blood stains from cotton fabric is to use *cold* water.
 - Concrete is made by using *cement*, *water*, and *fine gravel* (aggregate).
 - Iron rebar is used to *reinforce* concrete.
 - The material used to seal the porous pulp used in making paper is called *size*.
 - The largest user of paper is the *newspaper* industry.

- f. Shiny paper is made by winding paper onto large drums coated with *chromium*.
 - g. Curved glass is used to make lenses because it is *transparent* and *bends light*.
 - h. Glass used to make laboratory glassware is called *Pyrex*.
 - i. To make red coloured glass, an oxide of *gold* or *selenium* is used.
 - j. A natural fibre that is used to make denim is *cotton*.
 - k. One use for cement cribbing is *culverts, sewer mains, or well casing*.
 - l. ABS and PVC plumbing pipes and fixtures are made by the *extrusion* process.
 - m. A plastic material used to make insulation sheets is *polystyrene*.
 - n. Extrusion coatings are commonly applied to *wires and tools*.
3. Determine if the statements are true or false. Write **T** to indicate true and **F** to indicate false. If a statement is false, rewrite it to make it true.

 F a. All synthetics are nonbiodegradable.

Some synthetics are nonbiodegradable.

 F b. The action of decomposers is the only process that breaks down materials in the environment.

The action of decomposers is one of the processes that breaks down materials in the environment. Chemical action is the other.

 T c. New materials often replace old ones.

 F d. Animals are producers.

Animals are consumers.

 T e. Decomposers use enzymes to break things down.

 F f. Atoms are not recycled.

Atoms are recycled.

 T g. Development and use of materials and products is dependent on the interaction of science, society, and technology.

F h. An enzyme can break down many different substances.

An enzyme is matched to break down a specific substance.

 T i. A biodegradable substance can be decomposed by the action of organisms in the environment.

 T j. Chemical action is the primary way in which metals are broken down.

 F k. Everything is decomposed in a sanitary landfill.

Biodegradable materials are decomposed in a sanitary landfill.

 T l. Recycling is a better disposal method for glass and for metals such as aluminum.

Enrichment

1. Research and write a report on how to effectively manage solid waste.

Answers will vary. Your report should include two to five ideas on how to manage solid waste.

2. Using ten items from the chart in Activity 3 on new and old products, decide whether the new products are more economical, more environmentally friendly, and more efficient.

Your answers will vary depending on which ten items you selected.

Key to the Assignment Booklet

Section 1 Assignment (25 marks)

- (16 marks) 1. Fill in the chart on the response page by listing products made from each material. Then list the properties that make the material suitable for that object. Use the following chart for information. An example is done for you.

Answers may vary but could include the following examples.

Material	Product	Property
aluminum	pop cans, foil wrap, pots, bakeware, siding, TV antenna	smooth, nonporous, shiny, flexible, hard, no resilience
concrete	sidewalk, driveway, basement, footings	rough, porous, dull, rigid, hard, no resilience
brick	chimney, fireplace, planter, walls of building	rough, porous, dull, rigid, hard no resilience
wood	furniture, fences, houses, outdoor buildings	rough, porous, smooth, dull (shiny if finished), rigid, soft, no resilience
plaster	house walls, ceilings	smooth, porous, dull, rigid, soft, no resilience
metals	eating utensils, furnace ducts, keys, car bodies, pots, appliances, cans	smooth, nonporous, shiny or dull, flexible, hard, no resilience
glass	water glasses, jars, windows, lightbulbs, eye glasses, TV screen	smooth, nonporous, shiny, rigid, very hard, no resilience
ceramic	some plant pots, electric insulators, china, vases	rough and porous if not glazed, dull, rigid, soft, no resilience
rubber	electric cord insulation, tires, running shoe soles	rough, nonporous, dull, flexible, soft, high resilience
vinyl	car seat cover, car roof or door panels, garden hose	smooth, nonporous, some reflectance, flexible, soft, high resilience
plastic	kitchen utensils, food containers, eyeglass frames, car parts	smooth, nonporous, variable reflectance, variable flexibility, soft, variable resilience
fabric and textiles	clothing, furniture coverings, coats, jackets, tents	usually smooth and porous, usually dull, flexible, soft, high resilience
paper	newspapers, books, magazines, boxes	smooth, porous, usually dull, flexible, soft, slight resilience

- (9 marks) 2. Consider the three unnamed materials described in the following table. They represent actual materials but only their properties are listed. Use the properties given to select a suitable material that could be used to make each product listed on the response page. Place the letter of the material that you select for each product in the space provided. You may use more than one letter for some of the products. An example is done for you.

Product	Material
e.g. windows	<u>A</u>
a. insulation for wire	<u>C</u>
b. a canoe hull	<u>B</u>
c. electric wire	<u>A</u>
d. telephone	<u>B</u>
e. music records	<u>C</u>
f. automobile chassis (frame)	<u>A</u>
g. eyeglasses	<u>C</u>
h. a bridge spanning a river	<u>A</u>
i. refrigerator shell (outside)	<u>A</u>
j. plant pots	<u>A</u>
k. mirrors	<u>B</u>
l. trash containers	<u>A</u>
m. headlight lens	<u>B</u>
n. streetlight pole	<u>A</u>
o. burners for electric stove	<u>B</u>
p. drinking glasses	<u>B</u>
q. pop containers	<u>B</u>
r. garden hose	<u>A</u>

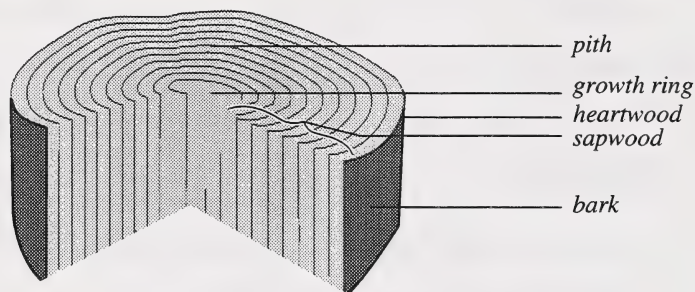
Section 2 Assignment (45 marks)

- (3 marks) 1. Describe the process of photosynthesis.

Photosynthesis is a process in which green plants manufacture food. The plant takes in carbon dioxide from the air and water from the soil. In the presence of sunlight and the green material called chlorophyll, carbon dioxide and water are changed into carbohydrates which can be found in the form of sugar, starch, or cellulose.

- (3 marks) 2. Use the diagram of the cross section of a tree on the response page and label the following parts:

- a. growth ring
- b. pith
- c. sapwood
- d. bark
- e. heartwood



- (4 marks) 3. Describe what cellulose is and some of its uses.

Cellulose is a polymer carbohydrate made from sugar monomers during photosynthesis. Its fibres are found in the walls of plant cells which support the plant in an upright position. It also contains the tubes for conducting water and plant nutrients and can be used to make pulp and paper.

- (10 marks) 4. Describe the function of each of the following parts of a tree.

- a. growth ring

A growth ring is the outside layer of a tree that is waterproof and protects the inside parts from injury.

- b. pith

The pith is the central part of a tree that grows outward to produce bark and inward to produce wood.

- c. sapwood

Sapwood is found in the centre of a tree. It indicates annual growth.

- d. bark

Bark is the portion that contains old growth rings or wood that is no longer alive but creates support for the tree.

- e. heartwood

Heartwood is found directly underneath the bark. It is alive, growing, and containing sap. It produces the growth ring which becomes heartwood in time.

- (5 marks) 5. Choose a synthetic fibre or fibres that may be suitable for

- a. waterproof rainwear

Acetate is suitable for waterproof rainwear.

- b. the sails for a sailboat

Nylon or dynel are suitable for sailboat sails.

- c. sportswear that may become wet but should dry quickly

Acrylic or dacron are suitable for sportswear.

- d. making fashionable, colourful summer clothing

Arnel or rayon are suitable for summer clothing.

- e. carrying packs that can become damp or wet but will not decay

Dynel or acrylic are suitable for packs.

- (4 marks) 6. When fibres are blended, the resulting material has properties of all the fibres in the mixture. Name the fibres that could be mixed with the following:

- a. cotton to reduce its wrinkling

Acrylic or dacron mixed with cotton will reduce wrinkling.

- b. cotton to make it shiny

Acetate or arnel mixed with cotton will make it shiny.

- c. rayon to make it more decay resistant

Dynel mixed with rayon will make it more resistant to decay.

- d. nylon to make it softer

Cotton mixed with nylon will make it softer.

- (6 marks) 7. Identify which of the following materials contains cellulose and which contains an organic compound.

- a. cotton

Cotton contains cellulose.

- b. nylon

Nylon contains an organic compound.

- c. rubber

Rubber contains an organic compound.

- d. paper

Paper contains cellulose.

- e. rayon

Rayon contains cellulose.

- f. wool

Wool contains an organic compound.

- g. pulp

Pulp contains cellulose.

- (10 marks) 8. a. Select ten items found inside and outside your home that are made from plastic and list them in the response page table.
- b. Use the following descriptions for each property of polyethylene to list which properties your plastic samples possess:

Answers may vary depending on collected samples but could include the following examples:

a. Plastic Item	b. Properties
<i>comb</i>	<i>hard, smooth, slight flexibility, nonporous, opaque, conductive, medium melting point</i>
<i>bread wrapper</i>	<i>soft, smooth, nonelastic, pliable, low tensility, malleable, nonporous, transparent, nonsoluble, low melting point</i>
<i>flower pot</i>	<i>hard, smooth or rough, nonelastic, not flexible, brittle, nonporous, opaque, nonsoluble, high melting point</i>
<i>ruler</i>	<i>hard, smooth, brittle, nonporous, transparent and opaque, nonsoluble, high melting point</i>
<i>fruit basket</i>	<i>hard, smooth, brittle, nonporous, opaque, nonsoluble</i>
<i>drinking glass</i>	<i>hard, smooth, brittle, nonporous, transparent, translucent, and opaque, nonsoluble, low melting point</i>
<i>storage container</i>	<i>hard, smooth, pliable, nonporous, transparent, translucent, and opaque, nonsoluble</i>
<i>trash container</i>	<i>hard, smooth, nonporous, opaque, nonsoluble, medium melting point</i>
<i>clothes hanger</i>	<i>hard, smooth, brittle, nonporous, opaque, nonsoluble, high melting point</i>
<i>pop bottle</i>	<i>hard, smooth, pliable, nonporous, transparent, nonsoluble, low melting point</i>

Section 3 Assignment (30 marks)

- (1 mark) 1. The more closely the carbon atoms are packed together, the more rigid and tough the polyethylene becomes. Which of the three types has the closest atoms?

The cross-linked chains are more closely packed.

- (9 marks) 2. Polyethylene will be harder, less flexible, and have a higher melting point with more closely packed atoms. What type of chain would most like be found in any **four** of the following plastic items?

- a. polyethylene garbage bag

The garbage bag would have a branched chain due to high flexibility.

- b. polyethylene molded container

The container would have an unbranched chain due to rigidity.

- c. polyethylene pop container

The pop container would have a branched chain due to high flexibility.

- d. polyethylene hair brush bristles

Hairbrush bristles would have a branched chain if highly flexible or an unbranched chain if rigid.

- e. polyethylene portable tape recorder case

A tape recorder case would have an unbranched chain due to rigidity.

- f. polyvinyl chloride phonograph record

The record would have a branched chain if highly flexible or an unbranched chain if rigid.

- g. polyvinyl chloride floor tile

The floor tile would have a cross-linked or unbranched chain due to rigidity.

- h. polystyrene wall tiles

Wall tiles would have a cross-linked or unbranched chain due to rigidity.

- i. polyurethane mattress padding

Mattress padding would have cross-linked or branched chain due to flexibility.

- (4 marks) 3. Cross-linked polyethylene chains form a polyethylene with greater strength, hardness, and higher melting point than the unbranched or branched chains. What does this statement indicate about the carbon atoms in the cross-linked polymer? Why does this give the chains greater strength, hardness, and higher melting points?

More of the carbon atoms are linked to other carbon atoms. This forms a strong covalent (bonded) structure. The carbon atoms of each chain are also pulled closer together because of this type of bonding which increases the strength.

- (3 marks) 4. Which type of polymer chain is best suited to make the following polyethylene material products?

- a. the best flexible squeeze bottle

A squeeze bottle should have a branched chain for high flexibility.

- b. a water container that gets bounced around during transportation

A water container should have an unbranched chain for having a tough semi-rigid property.

- c. a product that may be subjected to hot temperatures

A product that may be subjected to hot temperatures should have a cross-linked chain for a high melting point.

- (7 marks) 5. Each synthetic material is made from different substances and a different industrial process. Select **one** of the following materials and write a short report that describes what the material is made from, the industrial process for making the material, and what products are made from the material.

The information you need can come from several sources, including encyclopedias, library references, textbooks, and periodicals.

- acetate
- dynel
- acrylic
- orlon
- amel
- polyester
- dacron

Marks should reflect organization of information, introduction and conclusion, content, and general impression.

(6 marks) 6. Whether a material should or should not be used depends on how society benefits from its use and at what cost. Select any **two** of the following materials to answer the following questions.

- Plastics are one of the most widely used materials today.
- Detergents were developed during World War II to replace soap when fat used to make soap became scarce.
- Due to rising heat costs, urea formaldehyde foam insulation became popular. It was easier to inject liquid urea formaldehyde through holes drilled inside the walls of existing homes than to tear the walls apart to insert fibreglass insulation.
- Semiconductors are materials in which electrical conductivity can be controlled. They are used in transistors, microprocessing chips, memory chips, and other electronic components and devices. The automobile, computer, and programmable electronic devices of all sorts have increasingly been developed with these materials.

- a. What are the benefits in using the two materials?
- b. What are the costs to society that come from using the two materials?

Answers may vary but could include the following points:

Plastics

- a. *Plastics have the following benefits:*
 - *revolutionized making of products*
 - *allowed introduction of new products*
 - *inexpensive and multipurposed*
 - *easily molded, coloured and shaped, light, transparent or opaque, flexible, or rigid, resist decay*
- b. *The costs to society for using plastics include the following:*
 - *nonbiodegradable*
 - *accumulates in environment*
 - *creates waste problem, landfill costs*
 - *depletes nonrenewable resources*

Detergents

- a. *Detergents have the following benefits:*
 - *lathers and foams better than soap*
 - *can be specifically designed for many synthetic materials*

b. *The costs to society for using detergents include the following:*

- *not biodegradable*
- *accumulate in streams and lakes, are difficult to remove from water supplies*
- *kill fish populations, create environmental problems*

Urea Formaldehyde Foam

a. *Urea formaldehyde foam has the following benefits:*

- *efficient insulating material*
- *less expensive for older houses lacking insulation*

b. *The costs to society for using urea formaldehyde foam include the following:*

- *health hazard*
- *emits harmful fumes*
- *costly to remove*

Semiconductors

a. *Semiconductors have the following benefits:*

- *made microchips possible*
- *made smaller or miniature electronic devices possible*
- *consume less power, emit little heat, more reliable than tubes*

b. *The costs to society for using semiconductors include the following:*

- *none have been discovered*

SCIENCE 24

Module 7: Energy in Action



Learning Facilitator's Manual



**Distance
Learning**

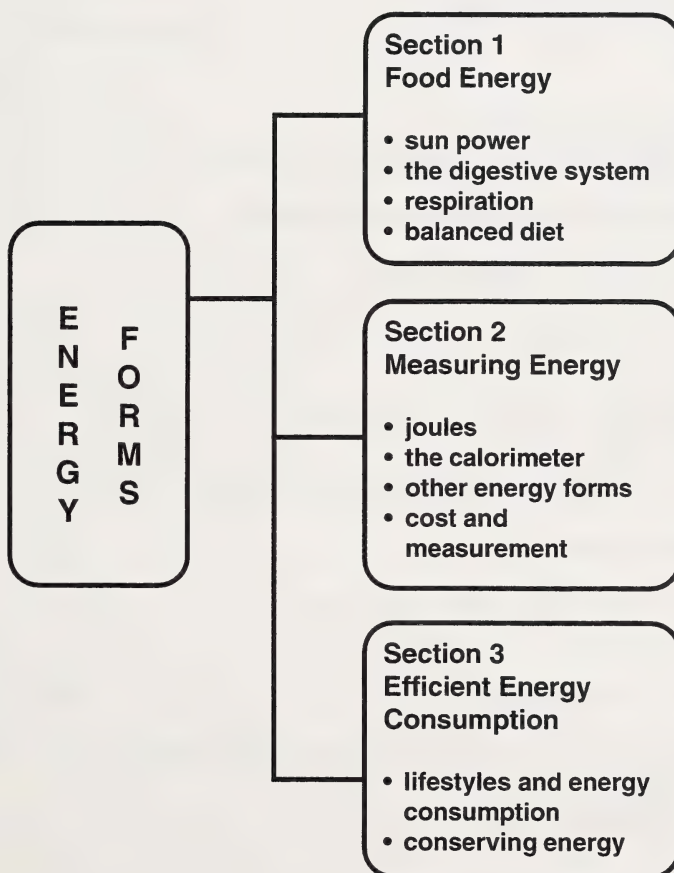
Alberta
EDUCATION

Module 7: Energy Forms – Overview

The emphasis in this module is on using energy. The ultimate source of all energy is the sun from which energy originates and can be traced. Solar energy is stored in food and is released to the body to power its life activities. The process of energy conversions performed by the human body and the basic components of a balanced diet form important components of study.

Since energy can be measured in quantitative terms, the units, equipment, and techniques used to measure energy from foods as well as other forms are considered.

Different energy forms are identified as well as personal energy consumption. The efficient and wise use of energy is also recognized.



Materials and Equipment

The following is a list of materials and equipment necessary to complete the investigations and activities in Module 7.

Section 1: Activity 1

Part A

- hammer and metal surface or mortar and pestle
- tincture of iodine or iodine indicator solution
- seed samples – corn, popcorn, dried peas, lentils, wheat, rice, tapioca, etc.
- pinch of baking flour
- pinch of cornstarch
- two sheets of white paper

Part B

- brown lunch bag paper
- cooking oil – e.g., corn, peanut, canola, vegetable
- a peanut
- other nuts, e.g., walnuts, macadamia, almonds
- hammer
- hard surface or mortar and pestle

Section 1: Activity 2

- small bowl
- flavoured or unflavoured gelatin powder
- hot water
- MSG (monosodium glutamate) or meat tenderizer

Section 1: Activity 3

- stop watch or clock with a second hand
- place to jog

Section 1: Extra Help

- miniature marshmallows (coloured ones, if possible)
- toothpicks
- cooking pot

Section 2: Activity 2

- 20 cm aluminum pie plate
- thermometer
- 2 pieces #18 wire, 3-5 cm long, or straight paper clip wire
- 2 bricks or a ring stand and ring
- 150 mL cool water
- metric measuring cup or 100 mL graduated cylinder
- food samples such as a shelled peanut, popcorn, dry cat or dog food, crouton
- matches

Section 2: Activity 4**Part A**

- 4 glasses or 4 100-mL beakers
- aluminum foil
- black paper
- scissors
- labels
- tape
- thermometer
- clock

Part B

- magnifying glass
- dish or spoon
- thermometer
- 10 cm × 10 cm white paper
- 10 cm × 10 cm black paper
- watch

Part C

- elastic band
- tuning fork
- jar or glass of water
- plastic wrap
- small amount of sand or table salt

Part D

- dry cell battery, 1.5 V
- DC voltmeter, 0 – 5 V
- DC ammeter, 0 – 5 V
- light bulb, 1.5 V
- lamp socket
- 5 electrical wires

Part E

- 1 hairdryer

Section 3: Activity 1

- electric meter
- paper and pencil

Possible Media

Video *Human Digestion* ACCESS Network

Video *Human Respiration* ACCESS Network

Evaluation

The evaluation of this module will be based on three assignments:

Section 1 Assignment	30 marks
Section 2 Assignment	45 marks
Section 3 Assignment	<u>25 marks</u>
TOTAL	100 marks

Section 1: Food Energy

This section deals with how solar energy is stored in foods you eat. A description of the body systems responsible for converting this food energy into energy for life processes and activities is discussed. The basic components of a balanced diet are also examined.

Section 1: Activity 1

1. Name four foods that are high in energy.

Some foods that are high in energy could include candy, cakes, pastry, desserts, alcoholic drinks, soft drinks, chocolate, jam, nuts, sweetened cereals, processed meats, bread, rice, and pasta.

2. Name four foods that are low in energy.

Some foods that are low in energy could include coffee, tea, diet soft drinks, spices, and vegetables such as broccoli, brussel sprouts, celery, radish, lettuce, cucumber, cabbage, and raw tomato.

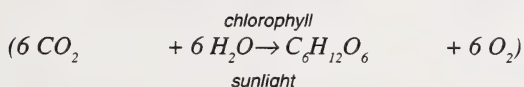
3. Where do you think the food you eat gets its energy from?

The food you eat gets its energy from one or more energy transfers, but ultimately it gets its energy from the sun.

4. Write the process of photosynthesis as a chemical word equation by using the given names for the chemicals involved. Show the reactants used and the products that are formed.

The process of photosynthesis can be given as the following:

carbon dioxide + water → sugar or starch + oxygen



5. Name four foods that are classified as starch.

Some foods that are classified as starch could include potatoes, bread and pastry, pasta, cereals, corn, and rice.

6. a. What things in the preceding diagram receive their energy directly from the sun by making their own food?

Energy is directly received from the sun by the potato and parsley.

- b. What things in the preceding diagram receive their energy from the sun indirectly?

Energy is indirectly received by cattle (from which the butter originated), and cattle or pigs (from which the meat originated).

7. Suppose you eat a ham, lettuce, and tomato sandwich. Starting with the sun, describe the energy transfers that were involved in your meal.

The grass on which the meat-producing hog depended, the wheat which was made into bread, and the tomato and lettuce obtained their energy directly from the sun during photosynthesis. The meat required several energy transfers before it ended up in the sandwich.

8. If you chewed a slice of bread or unsalted soda crackers for about ten minutes without swallowing, you may detect that they become sweet tasting. Suggest how the change could have occurred.

The bread or crackers contain starch which was changed into sugars by the chemicals in saliva.

9. Suggest the possible plant that each of the following foods originated from.

- | | | | |
|----------------|----------------------|--------------|----------------------|
| a. spaghetti | <u>wheat</u> | e. coleslaw | <u>cabbage</u> |
| | <u>sugar beet or</u> | | <u>canola, corn,</u> |
| b. candy floss | <u>sugar cane</u> | f. margarine | <u>sunflowers</u> |
| c. ketchup | <u>tomatoes</u> | g. pretzel | <u>wheat</u> |
| d. mustard | <u>mustard plant</u> | h. chocolate | <u>cocoa plant</u> |

10. Record your data in the table.

Type of Seed or Substance	Original Colour	Colour with Iodine Indicator
corn	yellow-white	blue-black
wheat	brown-white	blue-black
navy bean	white	blue-black
flour	white	blue-black
cornstarch	white	blue-black

11. Place a drop of water and a drop of iodine on a plain white sheet of paper. What colour changes do you see?

A blue-black colour change should be noted.

12. What evidence supports the statement that starch is added to paper?

The same colour change on a normal sheet of paper as with those substances that contained starch is observed.

13. From your observations, what conclusions can you make about the test for starch?

If a drop of iodine and water is placed on a substance and the colour change is blue-black, then the substance contains starch.

14. Place the items from the list in the appropriate columns.

- | | | |
|---------------------|------------------|---------------|
| • soda cracker | • egg | • coffee |
| • celery | • vegetable soup | • ripe banana |
| • white turkey meat | • potato chip | • bacon |
| • cheese | • white cake | • lettuce |

High Starch	Low or No Starch
<i>soda cracker</i>	<i>egg</i>
<i>vegetable soup</i>	<i>coffee</i>
<i>ripe banana</i>	<i>celery</i>
<i>potato chip</i>	<i>white turkey meat</i>
<i>white cake</i>	<i>bacon</i>
	<i>cheese</i>
	<i>lettuce</i>

15. Record your data in the table.


Type of Oil or Nut	Effect on the Brown Paper
<i>peanut</i>	<i>made the paper translucent</i>
<i>varies</i>	<i>made the paper translucent</i>
<i>varies</i>	<i>made the paper translucent</i>

16. From your observations, what conclusion can you make about peanuts and other types of nuts?

Since they make paper translucent much like the original oil placed on it, nuts must contain oil.

17. Examine this series of sketches. Place a number under each box to show the correct order of energy transfer.

The correct order of energy transfers is numbered as follows.

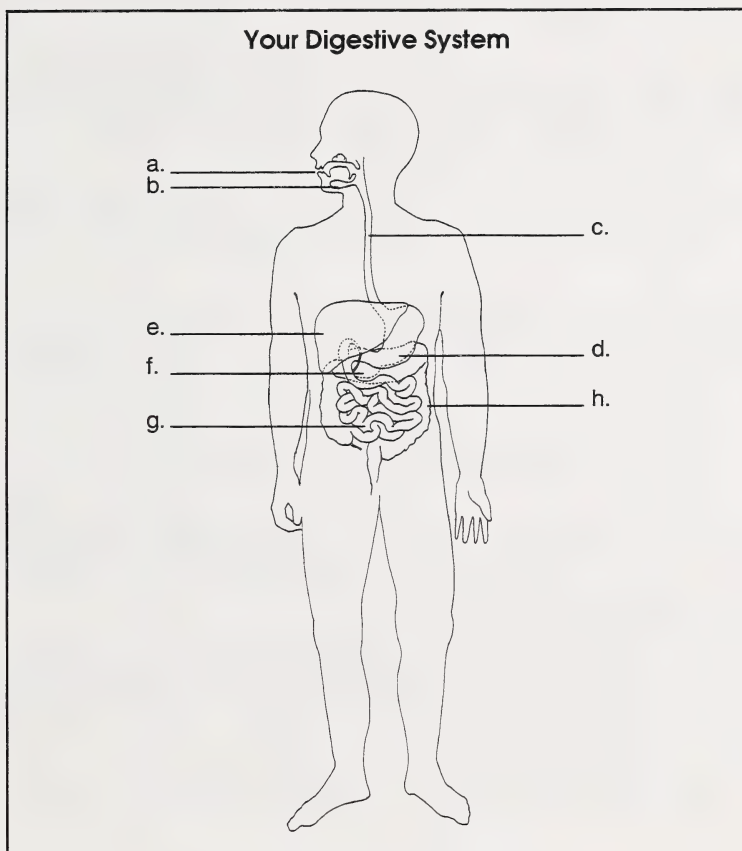
				
2	4	3	1	5

18. Draw a simple energy transfer that includes the following: barley, a woman, Hereford steer, sun, T-bone steak.

The energy transfers should be in the following order: sun → barley → Hereford steer → T-bone steak → woman

Section 1: Activity 2

1. Use the following diagram to identify the organs of the digestive system.



a. *mouth*

b. *salivary gland*

c. *esophagus*

d. *stomach*

e. *liver*

f. *pancreas*

g. *small intestine*

h. *large intestine*

2. Why is your favourite food very tasteless when you have a cold?

Your sense of smell is more acute than sense of taste so most of what you taste is due to smell. Taste is reduced by a cold since your sense of smell is most affected.

3. What is the function of saliva?

Saliva lubricates food for swallowing. It also begins to digest starch foods in the mouth.

4. What is an esophagus? What is its purpose?

The esophagus is the part of the digestive system that transfers food from the mouth to the stomach.

5. What is the function of the stomach?

The stomach is a part of the digestive system which receives food and breaks it down with digestive juices.

6. What are some of the usual causes of heartburn?

Heartburn is a burning acid sensation in the upper part of the stomach and along the esophagus brought on by eating certain substances such as spicy foods, high-acid foods, and alcohol.

7. Why is a stomachache difficult to diagnose?

What may appear like a stomach-ache could be appendicitis, food poisoning, bacterial infection, or other ailments exhibiting the same symptoms. It is difficult to make an internal diagnosis without medical knowledge.

8. Describe what happened to the gelatin.

The gelatin begins to break apart and become watery.

9. What happened to the large protein molecules in the gelatin?

The meat tenderizer has an enzyme that breaks the protein molecules in the gelatin into smaller molecules.

10. If bile is produced by the liver, why does it sometimes give you a bitter unpleasant taste when you belch?

When bile is released by the liver for digestion, trace amounts from the stomach are sometimes brought up with the release of gases from a belch to produce a foul taste of bile in the mouth.

11. What is the function of bacteria in your intestines?

The function of bacteria in the intestines is to break down undigestible solid food particles.

12. What are two functions of the large intestine?

The large intestine has these two functions:

- *absorbs water from the undigestible solids received from the small intestine*
- *forms solid wastes which are eventually eliminated*

13. Trace the path of a grilled cheese sandwich through your digestive system by describing the body systems responsible for converting the food into energy.

When a grilled cheese sandwich is eaten, the mouth breaks the food into smaller particles, provides saliva lubrication, and begins to digest the starch. The esophagus allows the food to be swallowed or travel into the stomach. The stomach mixes the food around thoroughly, separates it, and breaks it down with gastric juices. The small intestine continues to break the food down and absorbs the nutrients into the blood stream for cell energy. The large intestine completes digestion by producing undigested wastes.

Section 1: Activity 3

1. What activities did you participate in today that required energy?

Answers may vary but could include activities such as brushing teeth and walking to school.

2. What life processes require energy by your body right now?

Answers may vary but could include activities such as breathing, thinking, muscular movement, digestion, growth, and swallowing.

3. How can you tell when your body requires energy?

Symptoms may vary, but normally you can tell when your body requires energy if you become hungry, listless, or tired.

4. Record your results in the observation table.

Rate	Before jogging	After jogging
pulse rate (beats per minute)	<i>varies; mostly between 55-80</i>	<i>varies</i>
breathing rate (breaths per minute)	<i>varies</i>	<i>varies</i>

5. Use the data from the observation table to answer these questions.

a. How did jogging affect your breathing?

Jogging increased your rate of breathing because your body needs more oxygen for faster cell respiration.

b. How did jogging affect your heart rate (pulse)?

Your heart rate increased to pump more blood which carries the oxygen and glucose to your muscle cells.

c. Did you notice any changes in your legs? What did they feel like?

Your legs may feel tired because they use up the glucose which is the source of energy. There may also be a buildup of waste products from respiration.

6. Which of these activities burns energy faster? Why?

a. being sick or being healthy

When you are sick, your immune system has to use more energy to produce cells to fight the disease. You may have a fever which is an increase in the body's production of heat. Therefore, being sick burns energy faster than being healthy does.

b. sitting or standing

Standing burns energy faster because the leg muscles are active.

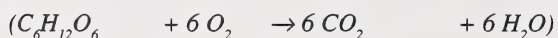
7. In what way is the release of energy from food in your muscle cells similar to the burning of fuel in a car?

The burning of fuel in a car also releases energy.

8. Write the process of respiration as a chemical word equation by using the given names for the chemicals involved. Show the reactants used and the products that are formed.

The process of respiration can be shown as the following:

sugar or starch + oxygen → carbon dioxide + water



9. In what two ways is the process of photosynthesis different from the process of respiration?

The process of photosynthesis differs from respiration in these two ways:

- *Chlorophyll and solar energy are required for photosynthesis to occur.*
- *Photosynthesis creates sugars and starches; respiration breaks them down.*

10. How does your body get the oxygen for respiration?

Oxygen is taken into your lungs during breathing. It passes from the lungs into the blood, which carries the oxygen to every cell in your body.

11. What body needs are supplied by the breathing process?

The breathing process supplies the body with the oxygen needed for cell respiration and eliminates the carbon dioxide produced during respiration.

12. Why do you breathe at a faster rate during exercise?

You breathe at a faster rate during exercise because vigorous exercise requires body cells to burn more glucose. Faster breathing brings more oxygen to the cells for respiration.

13. Why does your heart beat faster when you exercise more vigorously?

Your heart beats faster when you exercise more vigorously because hard exercise requires faster movement of the blood to the body cells. Oxygen and glucose need to reach the cells more quickly.

14. When is your breathing at its slowest rate? Why?

Your breathing is at its slowest rate when you rest or sleep since your body cells require less energy than during vigorous activity.

15. How do you know when your body runs out of energy?

Muscles tire when they run out of a supply of readily available glucose. It may be difficult to move your limbs or move at all.

16. Why would an athlete eat a spaghetti dinner instead of a chocolate bar to get the energy needed for competition?

A spaghetti dinner eaten before competition would release energy over a longer period of time than a chocolate bar.

17. Why do some athletes eat a chocolate bar instead of a spaghetti dinner during competition?

A chocolate bar eaten during competition would release energy much quicker than a spaghetti dinner.

Section 1: Activity 4

1. What foods do you consider to be nutritious?

Foods that are from the four basic food groups – milk products, meat and alternatives, grain products, and vegetables and fruits – are considered to be nutritious.

2. Why would you consider the foods in the preceding diagram as an undesirable choice of foods in a balanced diet?

The foods are considered undesirable food choices because they have little, if any, nutritional value essential for a balanced diet.

3. List six plants that can be used as a source for vegetable cooking oil.

Some sources for vegetable cooking oil could include olives, peanuts, sunflower, canola, corn, and soybean.

4. List six foods that may be cooked using vegetable oil or animal fats.

Some foods that are cooked using vegetable oil or animal fats could include fries, potato chips, fried chicken, doughnuts, bacon and eggs, hamburger, pastry, processed meats (such as bologna), and pasta.

5. In some foods, the fat is not visible, it is hidden. What snack foods are known to contain hidden fats?

Some snack foods known to contain hidden fats could include peanuts, nuts, sunflower seeds, potato chips, processed meats, cheese, doughnuts, cookies, and candy bars.

6. If fat is such a high energy food, why do nutritionists generally recommend only a moderate dietary intake of fats?

Nutritionists generally recommend only a moderate dietary intake of fat because fats are known to promote other problems such as heart disease, and the body must also receive a balanced diet of other nutrients.

7. List four body parts that are largely dependent on protein for their structure.

Answers may vary, but the following body parts are largely dependent on protein for their structure: muscle tissue; organs such as skin, heart, or brain; hair and fingernails; or cells such as nerve cells or blood.

8. Identify each of the following foods as either fat, protein, or carbohydrate.

- a. corn *carbohydrate*
- b. cheese *fat, protein*
- c. apple *carbohydrate (fructose, a simple sugar)*
- d. egg *protein*
- e. potato *carbohydrate (starch)*
- f. chicken *protein, fat*
- g. wheat cereal *carbohydrate (starch)*
- h. butter *fat*
- i. margarine *fat (oil from vegetables)*

9. Refer to Canada's Food Guide to examine these two menus. Answer the questions that follow.

Menu A	Menu B
70 g hamburger 1 hamburger bun 1 slice cheese 20 pieces potato fries 1 cola 1 chocolate bar	85 g roast beef 1 medium baked potato 125 mL cooked carrots 125 mL cooked broccoli 60 mL white sauce 1 large bun (whole wheat) 1 wedge apple pie 1 glass whole milk

- a. What essential foods for a balanced diet are missing from Menu A?

Vegetables and fruits and adequate milk products are missing from Menu A.

- b. Identify which menu contains more vitamins and minerals.

Menu B contains more vitamins and minerals.

- c. Plan a menu for your dinner this evening. Be sure to note how much of each item you plan to eat. Do not forget beverages and condiments.

Your menu should include the kinds and amounts of foods specified in the Canada Food Guide. You need 2-3 servings of meat and alternatives daily to get your protein. Choose leaner meats, poultry, and fish, as well as dried peas, beans, and lentils more often. You should have 5-10 servings of vegetables and fruit daily to get required vitamins and minerals. Choose dark green and orange vegetables and orange fruit more often. You also need the recommended serving of milk products. As well, you should have 5-12 servings of grain products daily, preferably whole grain and enriched products.

Your dinner menu should include foods from each of the four food groups. Beverages and condiments should reflect good food choices.

10. Why are milk products recommended by Canada's Food Guide?

Milk products are recommended by Canada's Food Guide to provide essential vitamins, minerals, and proteins that may not be found in other food groups.

Section 1: Follow-up Activities

Extra Help

1. What happens to solid food particles as digestion begins?

As digestion begins, solid food particles are broken down into smaller units.

2. In what way are melted marshmallows similar to the original marshmallows?

Melted and original marshmallows are similar to each other because they are still marshmallows.

3. In what way are melted marshmallows different from the original marshmallows?

Melted marshmallows differ from the original marshmallows because of their state and temperature.

4. In what way is digested food different from the original food?

Digested food differs from the original food because it has been changed into an entirely different form from the original.

5. Explain what has happened after food is digested and before the food energy can become body energy?

The digested food has to be absorbed and moved by the blood system to every body cell. Respiration occurs in all the body's cells. The glucose molecule releases its energy to the cell molecule adenosine triphosphate (ATP). This is the source of energy for all the cells' activities.

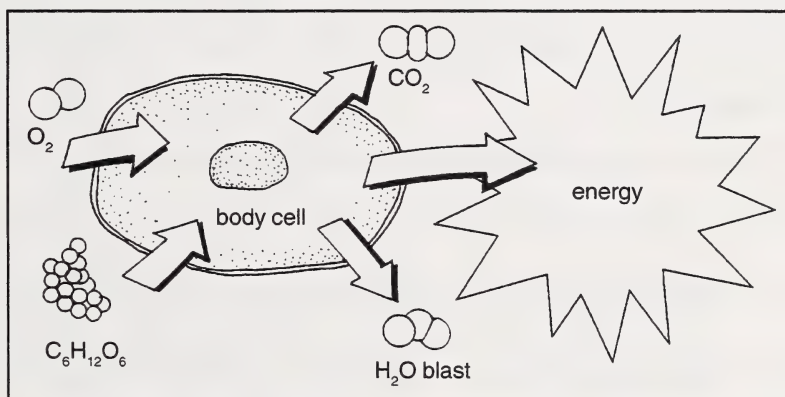
6. Energy is changed before it can be used by your cells. Fill in the missing step in this path of energy movement.

sun → corn → _____ → human

The missing step is an animal that converts the energy from the corn into meat that people ingest. Cattle, pigs, and chickens may be some suggestions.

7. Draw a diagram of a cell during respiration. Label the inputs – oxygen and glucose. Label the outputs – energy, water, and carbon dioxide.

A diagram of a cell during respiration would be similar to the given figure. Oxygen (O_2) and glucose ($C_6H_{12}O_6$) are inputs which produce the outputs water (H_2O), carbon dioxide (CO_2), and energy.



8. Suppose a teenager eats the following foods in one day:

- 1 cheeseburger
- 2 glasses orange juice
- 2 bags potato chips
- 2 pieces of white bread with jam
- 1 chocolate bar

- a. What foods could you add for balancing this diet? (Hint: Refer back to Canada's Food Guide.)

The following foods would balance the diet:

- 1-5 servings of fruits or vegetables
- 2-3 servings of milk products
- 1-2 servings of meat, fish, poultry, or other protein alternatives
- 1-8 servings of grain products

- b. What foods would you take away for balancing this diet?

The foods that need to be eliminated are "empty calorie" foods (foods that have only energy value, but no vitamins, minerals, or proteins) like jam and chocolate bars. The white bread provides energy but has few vitamins and minerals. The potato chips are high in fat and would not be suggested to someone who is on a diet.

Enrichment

1. Use library research to write a report on **one** of the following:

- a. the function of the pancreas and liver in the digestive process

Answers may vary. The main function of the pancreas should include its secretion of the enzymes trypsin, amylase, and lipase which continue to digest or break down protein and fats. The liver receives blood sugar or glucose and stores it as glycogen, a form of carbohydrate, for later use. It also produces bile which breaks down fat molecules.

- b. the function of enzymes in digestion

Answers may vary. Enzymes are catalysts required for most of the chemical reactions happening in living cells. Enzymes could include ptyalin in saliva which lubricates and changes starch into sugar. Pepsin produced in the stomach breaks down protein. The small intestine receives the enzymes trypsin, amylase, and lipase secreted by the pancreas which continue to digest or break down protein and fats.

2. Examine the labels of five grocery items such as crackers, sauces, etc. and list the names for the sugar found in the food item.

Answers may vary. It is very difficult to live without consuming sugar in most processed foods. The label could identify any of the following sugars: sugar, dextrose, sucrose, lactose, maltose, fructose, corn syrup, invert sugar, molasses, maple syrup, honey. Sugar-free alternatives would not list the sugar forms.

3. Locate the food contents of three different breakfast cereals.
 - a. Use the information given on the cereal box to fill in the information in the chart.

Answers may vary. In general, ingredients are listed by weight with the largest amount first. Lesser amounts of the other ingredients are listed next. Food nutrients in terms of energy, protein, vitamins and minerals may also be listed.

Answers may vary. For example, the nutritional information appearing on a box of a certain cereal box appears as Brand A includes:

Brand Name	Brand A: An example is given.	Brand B:	Brand C:
Serving Size	30 g		
Main Ingredients	100% whole wheat		
Energy Total	430 kJ		
Protein Total	2.5 g		
Carbohydrates Total	46.7 g		
Fat Total	0.3 g		
Sodium Total	5 mg		
Vitamin Total	varies		
Iron Total	28% R.D.I.		

Note: R.D.I. – Recommended Daily Intake

- b. What is the main ingredient in Brand B?

Answers may vary. Generally, the main ingredients are wheat, rice, or corn flour.

- c. How large is the serving size for Brand A?

Answers may vary. Portion sizes are usually 250 mL or 30-40 g.

- d. Which cereal has the most energy?

Answers may vary. Cereals with high amounts of sugar and fat added have the most energy.

- e. Which cereal has the most nutrients besides sugar or starch?

Answers may vary. Cereals high in nutrients include all parts of the grain not just the flour (starch). Usually cereals that need preparation like rolled oats are more nutritious than cold ready-to-serve cereals.

Section 2: Measuring Energy

This section deals with identifying and defining the units for measuring food energy. Various equipment and techniques for measuring energy are explored. Students are also given the opportunity to identify other forms of energy.

Section 2: Activity 1

1. Explain how Dmitri does work when he eats spaghetti with a fork.

Dmitri does work by lifting the fork with spaghetti from the plate to his mouth. Force is applied on the fork to collect a small quantity of spaghetti on the tines and move it through a distance from the plate to his mouth.

2. Explain why Shannon does not do any work as defined when she spends five exhausting hours intensively studying for a mid-term.

Shannon may be exhausted from intensive studying, but unless she applied a force through a distance for five hours, she probably did not do much work as defined. Her only work could be a result of flipping pages, writing notes, or snacking, but it could not be a result from using her mind to concentrate.

3. If Habib irons his shirt and pants, is work being done? Explain.

Habib does work as he irons his clothes. By exerting a force on the iron to hold it and move it through a distance over the fabric, work is being done.

4. David, Holly, and their dad spent an entire day and a great deal of energy trying to move a huge stone found in the middle of the family farm field. If they were unsuccessful but were exhausted from their efforts, was any work done? Explain.

Although David, Holly, and their dad spent an entire day and a great deal of energy trying to move a huge stone found in the middle of the family farm field, work was not done if they were unsuccessful in moving the stone. They were probably exhausted from applying a force but the force did not move through a distance.

5. Use the information in the preceding menu to determine how many kilojoules of energy you would obtain from eating the following meal.

1 cheeseburger	_____ kJ	20 french fries	_____ kJ
15 mL ketchup	_____ kJ	1 vanilla milkshake	_____ kJ
Total kilojoules = _____ kJ			

The energy obtained from eating the meal is $1280 + 250 + 920 + 1200 = 3650$ kJ.

6. Eating french fries with gravy would add ($2435 - 920 =$) **1515** kilojoules to your meal.
7. Use the energy amounts from the cafeteria menu to calculate calories in the following. (Hint: Divide the number of kilojoules by 0.0042.)
- The number of calories in a cheeseburger is $1280/0.0042 = 304\ 762$ calories.
 - The number of calories in a vanilla milkshake is $1200/0.0042 = 285\ 714$ calories.
 - What problem do you recognize with these calculations?

These calculations involve large numbers.

8. Use the calculated energy from the previous question to calculate the energy in Calories. (Hint: Divide calories by 1000 to obtain Calories.)
- The number of Calories in a cheeseburger is $304\ 762/1000 = 305$ Calories.
 - The number of kilocalories in a vanilla milkshake is (Remember: 1 Calorie = 1 kilocalorie)

The number of kilocalories in a vanilla milkshake is $285\ 714/1000 = 286$ kilocalories (or 286 Calories).

9. If a deluxe hamburger has 2520 kilojoules, how many Calories does it have?

A deluxe hamburger having 2520 kilojoules has $2520\text{ kJ}/4.2 = 600$ Calories.

10. Calculate the number of Calories in a meal consisting of two pieces of fried chicken, fries and gravy, and a soda pop.

The number of Calories in the selected meal is $5395 \text{ kJ} / 4.2 = 1285 \text{ Calories}$ ($1 \text{ Calories} = 4.2 \text{ kJ}$).

Section 2: Activity 2

1. Why is the water container in a bomb calorimeter well-insulated?

The water container in a bomb calorimeter is well-insulated to prevent exchange of heat between the calorimeter and the surroundings.

2. Why is the temperature of the water inside a bomb calorimeter measured before and after a food sample is burned inside the reaction chamber?

The temperature of the water inside a bomb calorimeter is measured before and after a food sample is burned inside the reaction chamber to determine the temperature change resulting from the energy released by the sample.

3. Why is the energy absorbed by the water inside a bomb calorimeter equal to the energy released by a food sample burned inside the reaction chamber?

The energy absorbed by the water inside a bomb calorimeter is equal to the energy released by a food sample burned inside the reaction chamber because the same energy was transferred from substance to another. The law of conservation of energy states that energy cannot be created nor destroyed, but it can be transferred from one substance to another.

4. If the initial temperature of water is 22.0°C and the final temperature of water is 31.2°C , what is the temperature change (Δt)?

If the initial temperature of water is 22.0°C and the final temperature of water is 31.2°C , the temperature change is $31.2^{\circ} - 22.0^{\circ} = 9.2^{\circ}\text{C}$.

5. The combustion of a marshmallow sample in a bomb calorimeter causes 1.00 kg of water to rise from 22.10°C to 24.60°C . Calculate the heat produced by this reaction.

The heat produced by the combustion of a marshmallow sample when 1.00 kg of water rises from 22.10°C to 24.60°C is calculated as follows:

$$\begin{aligned}\text{heat energy} &= m\Delta t c \\ &= 1000 \text{ g} \times 2.50^{\circ}\text{C} \times 4.2 \text{ J/g}\cdot^{\circ}\text{C} \\ &= 10\,500 \text{ J} \\ &= 10.5 \text{ kJ}\end{aligned}$$

The heat energy is 10.5 kilojoules.

6. A meat sample is burned in a bomb calorimeter. It causes 1.00 kg of water to rise from 25.20°C to 28.80°C. Calculate the heat produced by this reaction.

The heat produced from burning a meat sample causing 1.00 kg of water to rise from 25.20°C to 28.80°C is calculated as follows:

$$\begin{aligned}\text{heat energy} &= m\Delta t c \\ &= 1000 \text{ g} \times 3.60^\circ\text{C} \times 4.2 \text{ J/g}\cdot^\circ\text{C} \\ &= 15\,120 \text{ J} \\ &= 15.1 \text{ kJ}\end{aligned}$$

The heat energy is 15.1 kilojoules.

7. Why is polystyrene a suitable material for constructing a simple calorimeter?

Polystyrene is a suitable material for constructing a simple calorimeter because it is an excellent insulator of heat. For example, it is used to insulate buildings and refrigerators.

8. What is the purpose in using the bottom cup?

The purpose in using the bottom polystyrene cup is to provide additional heat insulation by the trapped air. This is similar to the dead air space between two panes of glass in a window or the fibres in fibreglass insulation.

9. The upper cup is usually filled with 100 mL of water.

- a. What is the purpose of the water?

The purpose of the water is to absorb the heat released by the sample.

- b. Why is this amount used?

The upper cup is usually filled with 100 mL of water because 100 mL of water equals 100 g of water at 4°C, when water reaches its maximum density. At room temperature the difference is only slight.

10. What limitations would you encounter in using a simple calorimeter such as this one to determine the energy of a food sample?

One limitation that you would encounter in using a simple calorimeter such as this one to determine the energy of a food sample would be the difficulty in burning the food sample inside the water.

11. Use the data obtained in the observations table to calculate the amount of energy in the samples:

- a. the peanut

- b. the popcorn
- c. the dry cat or dog food
- d. other

a. – d. Energy calculations based on the data obtained in the observations table will vary. A large experimental error is to be expected due to energy transfers, mass of sample, and the type of calorimeter used.

12. Which food had the most energy?

The peanut should have the most energy.

13. The peanut has a high fat content. Did it release more or less energy than the popcorn which is a carbohydrate?

The peanut has a high fat content and should release almost twice the energy of the popcorn which is a carbohydrate.

14. If the accepted energy content for any of the substances used in this investigation were listed in the Appendix, it is likely that there would be a large discrepancy between the actual values and the ones that you observed in the investigation. What reasons would account for this?

Some reasons for a large discrepancy in the energy content of foods between the actual values and the ones that you observed in the investigation could include the fact that the calorimeter absorbed heat from matches in addition to burning food, the surroundings transferred heat to the calorimeter, and the food samples were not a standard mass.

15. Explain how heat energy stored in various foods can be measured.

Heat energy stored in various foods can be measured using a calorimeter. It is a device which measures temperature changes in a given mass of water from energy which is released or absorbed by the substance tested. You can calculate the energy that each substance possesses by multiplying the mass of water by the temperature change by the heat capacity for water.

16. What amount of energy would you expect to obtain from a carbohydrate compared to an equal amount of fat?

You should expect to obtain about half the amount of energy from a carbohydrate compared to an equal amount of fat.

17. What was the **control variable** in the bomb calorimeter experiment?

The control variable in the experiment was the use of the same mass (100 g) of food for each tested sample.

18. What was the **manipulated variable** in the bomb calorimeter experiment?

The manipulated variable in the experiment was the type of food selected for testing.

19. What was the **responding variable** in the bomb calorimeter experiment?

The responding variable in the experiment was the amount of energy released by the food samples.

Section 2: Activity 3

1. When a speeding car is involved in a collision with a pole, what happens to the car's energy?

When a speeding car is involved in a collision with a pole, the kinetic energy of the speeding car is changed into potential, sound, and heat energy.

2. When a waterfall or running water produces electricity by turning an electric generator, what happens to the energy?

When a waterfall or running water produces electricity by turning an electric generator, its kinetic energy is changed into mechanical, sound, and electrical energy.

3. When wood is burned in a fireplace, what happens to its chemical energy?

When wood is burned in a fireplace, its chemical energy is changed into light, sound, heat, and potential energy.

4. What happens to the chemical energy of gasoline when it burns in a car engine?

When gasoline burns in a car engine, chemical energy is changed into kinetic and heat energy.

5. List four common examples where an object, due to its motion, is said to possess kinetic energy.

Answers may vary but common examples where objects are said to possess kinetic energy could include the following:

- any object in flight such as a baseball, bullet, airplane, bird, or kite
- any object in motion such as a flowing river, wind, road traffic, train, or avalanche

6. Why is a stretched rubber band considered to possess potential energy?

A stretched rubber band is considered to possess potential energy because its position has changed or it now has stored energy capable of being released.

7. Suggest two common examples where an object, due to its position, is said to possess potential or stored energy.

Answers may vary but common examples where objects are said to possess potential or stored energy could include such examples as a dammed-up water supply, a boulder on a mountain top, gasoline, a battery, a skier about to attempt a ski jump, and a bullet about to be fired.

8. Why does the car on the top of the hill exhibit potential energy?

The car on the top of the hill exhibits potential energy because its higher level position can change to a different or lower level.

9. Describe the energy changes involved as the car changes its position from the top of the hill to the bottom of the hill.

The car on the top of the hill exhibits potential energy because it has the potential to roll down the hill. In going to the bottom of the hill, when the car is in motion, the car has converted its potential energy into kinetic energy.

10. Classify the following examples as having potential or kinetic energy and state the reason why.

- a. a match inside a packet

The match inside a packet has potential energy until it is lit.

- b. water running from a tap

Water running from a tap is moving; therefore it has kinetic energy.

- c. stretched elastic band

A stretched elastic band has stored energy or has changed its position; therefore it has potential energy until it is released.

- d. a glass of milk

The nutrients in a glass of milk are potential or chemical energy until they are converted through body respiration.

- e. a bird singing

A singing bird produces air vibrations, a form of kinetic energy changed into sound.

- f. a new 9-volt alkaline battery

The chemicals in a new 9-volt alkaline battery are stored as chemical potential energy.

11. Where is nuclear energy produced on Earth and for what purpose?

Nuclear energy is produced on Earth in nuclear reactors for generating electricity.

12. Give common examples where light energy is produced.

Answers may vary, but common examples where light energy is produced could include the following: fire, car headlights, flashlight, lamp, electric bulb, stars, fireflies.

13. Give common examples where heat energy is produced.

Answers may vary, but common examples where heat energy is produced could include the following: fire, motors, sun, chemical reactions, furnace, impact, friction.

14. Why is nuclear energy considered a threat by so many people?

Nuclear energy is considered a threat by many people if its use is for nuclear weapons capable of vast destruction.

15. How is nuclear energy beneficial?

Nuclear energy is beneficial to mankind when used for the following:

- *electricity production*
- *medical use – Radioactive isotopes such as cobalt-60 are used in treating cancer.*

16. Give examples that depend on sound energy.

Answers may vary, but common examples that depend on sound energy could include the following: the telephone, musical instruments, conversation, thunder, a falling tree, TV, radio, a barking dog.

17. Name the sources of sound energy shown in the preceding diagram.

The sources of sound energy include the people, TV set, telephone, traffic, doorbell, drums, and food mixer.

18. Is sound always beneficial? Explain.

Sound is generally beneficial to most people as indicated by those who lose the ability to hear, but very loud noises such as thunder, jets, and loud music could be irritating or even painful.

19. Give four common examples that depend on electrical energy.

Answers may vary, but common examples that depend on electrical energy could include the following: appliances, motors, computers, calculators, artificial lighting, radio and TV broadcasting.

20. What type of energy is illustrated in the preceding diagram and where did people get their energy to do these jobs?

Mechanical energy is illustrated by bicycle-riding, painting, and cutting the hedge. People got their energy from food, a form of chemical energy.

21. What type of energy powers something like a car or a lawnmower? Where does this energy come from?

Mechanical energy powers a lawnmower or car. The energy comes from gasoline, a form of chemical energy.

22. Identify six different forms of energy in the illustration and indicate how they are used.

These are some different forms of energy found in the illustration:

- *Sound energy comes from the portable stereo and the people.*
- *Electrical energy powers the portable stereo.*
- *Chemical energy is produced from human respiration.*
- *Light energy must be there for the people to see their surroundings.*
- *Mechanical energy moves the tapes and moves body joints.*
- *Heat energy is generated by the dancing bodies, the moving parts in the equipment, and the flow of electrical current.*

23. What energy changes are involved when toast is made in a toaster or charcoal is burned in a grill?

Electrical energy is changed into heat energy when toast is made. Chemical energy is converted into heat energy when charcoal briquettes are burned.

24. What form of energy is represented by the examples in the preceding diagram? Why?

Mechanical energy is represented by the examples because moving parts are involved. These parts are either moving or capable of moving.

25. Turn a radio on and listen to a station for one minute before answering the next questions.

- a. Describe the forms of energy that the radio represents.

The form of energy that the radio represents is electrical energy which converts the radio waves to sound energy.

- b. Describe what happens to your eardrum.

Your eardrum vibrates from the sound waves it receives from the radio and this is translated into auditory messages by your brain.

- c. Describe the forms of energy represented by this activity.

The forms of energy represented by this activity could include sound, electrical, and heat energy.

26. Describe the forms of energy involved when water behind a dam is released to operate a generator in a hydroelectric plant.

Water behind a dam is a form of potential energy due to its position. When it is released, it is changed into kinetic energy. This becomes mechanical energy as the generator is operated in the hydroelectric plant. The generator produces electrical energy.

27. Describe the forms of energy involved when wind moves a sailboat across a lake.

When wind moves a sailboat across a lake, one object (the wind) transfers its kinetic energy to another object (the sailboat).






28. Describe the forms of energy involved when a program is broadcast on television.

When a program is broadcast on television, electrical energy is changed into sound, light, and heat energy.

29. Describe the forms of energy involved when clouds are produced.

When clouds are produced, solar energy changes the potential energy of water into kinetic energy as the water molecules move upward. Clouds contain kinetic energy if they are in motion. They contain potential mechanical energy which becomes kinetic mechanical energy during a falling rain.

30. Fill in the table by identifying the original energy form and the form that it becomes.

Example	Original Energy Form	New Form of Energy
yo-yo 	<i>gravity potential</i>	<i>kinetic</i>
coffeemaker 	<i>electric potential</i>	<i>heat</i>
telephone 	<i>electric potential</i>	<i>sound</i>
climbing a ladder 	<i>chemical from glucose</i>	<i>mechanical and heat</i>
lightning 	<i>electrical</i>	<i>light and heat</i>

Section 2: Activity 4

1. How could the energy equivalents in the preceding table be converted to megajoules?

*Energy in kilojoules can be converted to megajoules by dividing kilojoules by 1000
(1 MJ = kJ/1000).*

2. Which fuel has the highest amount of heat energy per kilogram?

Natural gas and propane have the highest amount of heat energy per kilogram.

3. Which fuel has the least amount of heat energy per kilogram?

Wood and coal have the least amount of heat energy per kilogram.

4. How much heat energy does fuel oil provide per kilogram compared to wood?

Fuel oil provide almost three times as much heat energy per kilogram as wood.

5. Use the given data to predict why propane is becoming more popular as a fuel for trucks and cars.

Propane is becoming more popular as a fuel for trucks and cars because it releases about 15% more heat energy per kilogram than gasoline. The cost for propane conversion may offset its lower operating cost.

6. Explain how the amount of energy from the given fuels could be determined from calorimeter measurements.

The fuels could be burned in a calorimeter. The amount of energy could be calculated using the energy absorbed by a measured mass of water, its temperature change, and heat capacity.

7. In which beaker or glass did the water get the hottest?

The water in Glass D should get the hottest.

8. Where did the heat come from?

Heat is converted from radiant solar energy. It is absorbed by the black paper, reflected by the aluminium foil, and transferred to the water.

9. Why is more energy trapped by Glass D which has aluminum foil placed behind it?

Aluminium foil is put behind Glass D so that it can reflect radiant solar energy to the black paper which absorbs it. Aluminium foil reflects heat.

10. From your observations in this investigation, what conclusion can you make about dark surfaces and surfaces such as aluminum?

Dark surfaces such as black paper absorb heat; shiny surfaces such as aluminium foil reflect heat.

11. Explain, in terms of heat absorption and reflection, why the temperature is much greater inside an automobile than outside on a hot summer day.

On a hot summer day, the temperature inside an automobile is much greater than outside because a dark surface such as the car interior absorbs heat and the glass reflects heat back inside the car.

12. Assuming that the rise in temperature per minute remains the same, how long would it take for the temperature to reach the boiling point of water (100°C)?

Answers may vary, but assuming that the rise in temperature per minute remains the same, the length of time it would take for the temperature to reach the boiling point of water (100°C) would be

$$\frac{100^{\circ}\text{C} - \text{starting temperature in } ^{\circ}\text{C}}{\text{rise in temperature per minute}} = \text{time required in minutes}$$

13. Why does black paper ignite faster than white paper?

Black paper ignites faster than white paper because black surfaces absorb heat and white surfaces reflect it.

14. Explain how bottles thrown out of a car window could start forest fires.

When bottles are thrown out of a car window they can start forest fires if the bottles break. Broken bottle glass has a curved surface much like a concave mirror. This surface can focus sunlight on a combustible material.

15. What two factors could determine the maximum amount of solar energy that can be gathered by a typical high technology collector panel?

The tilt or angle of the collector, the latitude or amount of sunshine received, and design are some factors determining the maximum amount of solar energy that can be gathered by a typical high technology collector panel.

16. Buildings that rely on solar energy generally have a dark or black-coloured roof, mechanical equipment, and circulating pipes. Why?

Buildings that rely on solar energy generally have a dark or black-coloured roof, mechanical equipment, and circulating pipes to increase the amount of radiant energy absorbed.

17. How does the construction design of a solar dependent house differ from a conventional type of residence?

The construction design of a solar dependent house differs from a conventional type of residence in the extensive use of a sloping exterior and windows on the roof and walls for capturing maximum sunlight.

18. Besides the amount of sunshine, what other factors could limit the popularity of using solar energy for dwellings in northern Canadian climates?

The high cost of solar collector panels and the mechanical devices needed for energy transfers may be a limiting factor for solar energy dwellings in northern climates. Alternate conventional energy resources may be still be required for winter months.

19. Why are curved parabolic mirrors or shiny surfaces often used to design solar collector ovens and cooking devices? Where would these devices be most popular?

Curved parabolic mirrors or shiny surfaces are often used to design solar collector ovens and cooking devices because they reflect and focus solar energy. The devices would be most popular in tropical areas receiving large amounts of sunshine.

20. A bank of silicon solar cell collectors change solar energy directly into electricity. Where do you think these devices would be used?

A bank of silicon solar cell collectors to change solar energy directly into electricity is used in satellites and remote telecommunication stations.

21. Describe what happened.

The tuning fork produces a musical sound.

22. Describe what happened.

The water produces a series of circular small waves or ripples from the point in which the tuning fork touches it to its outer edges, similar to what happens when a rock is thrown into water.

23. Describe what happened.

The small amount of sand or salt particles from a shaker begins to vibrate or move on the surface of the plastic wrap.

24. Why would it be difficult for you to make measurements of the frequency or the vibrations per second created with a tuning fork in this investigation?

It would be difficult to make measurements of the frequency or vibrations per second created with a tuning fork in this investigation because the number of vibrations per second are too numerous to count.

25. Does this mean that frequency measurements for this investigation cannot be made? Explain.

This does not mean that frequency measurements for this investigation cannot be made. It only means that a method would have to be found to count the numerous vibrations per second rapidly and accurately.

26. Suggest how frequency measurements for this investigation could be made.

Frequency measurements for this investigation could be made by using electronic equipment capable of counting numerous vibrations per second.

27. Suggest why many musicians and many people who listen to amplified music could develop hearing problems.

Musicians and many people who listen to loud music could develop hearing problems from the very powerful sound energy produced by amplified music. Powerful eardrum vibrations may be excessive and cause damage.

28. What precautions should people take when they work in a noisy environment such as a rocket launch or an area where a jackhammer or heavy machinery is used?

One precaution that people could take when they work in a noisy environment is to wear ear protection.

29. Name three occupations where sound can cause damage to your ears.

Answers may vary, but possible areas where sound can cause damage to your ears could include the operation of explosives, weapons, or the jackhammer and heavy machines, or nearness to aircraft take-offs or rocket launches.

30. Suggest three other sources of sound having a decibel rating above 120 dB.

Answers may vary, but sources of sound with a decibel rating above 120 dB could include explosions, thunder, avalanches, earthquakes, volcanic eruptions, or rocket lift-offs. The noise would be very loud and painful to the ears.

31. Suggest three other sources of sound or environments having a decibel rating below 40 dB.

Answers may vary, but environments with a decibel rating below 40 dB could include libraries, a classroom during an exam, a house or hospital at night, a detention room, and a funeral home. Sources of sound with a decibel rating below 40 dB could also include a sleeping animal, a purring cat, a book page being turned, walking on carpeted floor, a wrist watch or electric clock ticking, heart beating, and some insects flying.

32. Predict the noise level or decibel reading in a classroom during an exam or library use. Explain what sounds you used in making your prediction.

Answers may vary, but a predicted noise level of about 30 to 50 dB in a classroom during an exam or library use is not unusual. This is less than a reading of 60 dB for conversation which would be minimal during an exam or library use, but above a whispering level. Sounds would still be made by people coughing or shuffling feet or by outside traffic noise coming into the room.

33. Estimate the average noise level or decibel reading that you encounter on a daily basis and explain the reason for your answer.

Answers may vary, but a predicted or estimated noise level or decibel reading of about 70 dB would be an expected average that you would encounter on a daily basis. It is above the conversational level but below the noises that are rated above the 80 dB reading that you live with on an occasional basis.

34. Why is the fluorescent lamp more efficient than an incandescent light bulb?

A fluorescent lamp is more efficient than an incandescent light bulb because it gives more lumens per watt.

35. Explain how a shock from static electricity is produced.

Static electricity is produced by friction, such as walking on a carpet, which builds up a negative charge. When a person touches another, the negative charge is discharged resulting in a shock.

36. a. What magnet polarities will pull two magnets together?

If two magnet polarities are different, the magnets will be pulled together.

- b. What magnet polarities will push them apart?

If the two magnet polarities are similar, the magnets will be pushed apart.

37. Use a check mark to summarize which charges attract and which charges repel each other in the following table.

Charges	Attract	Repel
+ -	✓	
- -		✓
+ +		✓
- +	✓	

38. How much energy does a 100 watt light bulb use in 1 hour?
(Hint: 1 hour = 3600 seconds)

The energy that a 100 watt light bulb uses in 1 hour may be calculated as follows:

$$\begin{aligned}\text{Energy} &= \text{power} \times \text{time} \\ &= 100 \text{ W} \times 3600 \text{ s} \\ &= 100 \text{ J/s} \times 3600 \text{ s} \\ \text{Energy} &= 360\,000 \text{ J or } 360 \text{ kJ}\end{aligned}$$

The energy used is 360 kJ.

39. What is the reading in kilowatts (kW) of the meter in May?

The reading of the meter in May is 12 011 kW•h.

40. a. If the April reading in kilowatts was 11 690, how many kilowatt-hours of electrical power were used between April and May?

The number of kilowatt-hours of electrical power that was used between April and May is
 $12\,011 - 11\,690 = 321 \text{ kW}\cdot\text{h}.$

- b. If the cost per kilowatt-hour is \$0.17, what is the cost of power consumption based on the meter readings?

The cost of power consumption based on the meter reading is
 $321 \text{ kW}\cdot\text{h} \times \$0.17/\text{kW}\cdot\text{h} = \$54.57.$

- c. How would this cost compare during the winter or summer months? Why?

The cost of power consumption during the winter months would be higher; the cost during the summer months lower. Cold temperatures and fewer daylight hours during winter increase the demand for power. Warmer temperatures and more daylight hours would decrease power demands, unless air conditioning is used.

41. Examine the advertisement for the two hairdryers. Which hairdryer has the most power? The 1500-watt hairdryer costs \$2 more than the other. Which one is the better buy? Why?

The 1500-watt hairdryer has the most power. It probably is the better buy because it delivers more power for only two dollars more.

42. Using the formula, substitute your data for volts and amperes, to find watts. How many watts of power did the light bulb use?

Answers may vary, but assuming a power source of 1.5 V and 8 A, the light bulb uses 12 W of power.

Power = current \times voltage

$$W = 8 \text{ A} \times 1.5 \text{ V}$$

$$= 12 \text{ W}$$

43. Check the wattage of several light bulbs. List three ratings and indicate where the light bulbs are used.

Answers may vary but could include a 60- or 100-watt bulb in a table lamp, a 40-watt bulb in the hallway, and a 25-watt lightbulb inside an oven.

44. Repeat this investigation with another home appliance such as a toaster and record the following information:

Answers may vary but could include examples such as the following:

<i>appliance:</i>	<i>electric kettle</i>	<i>iron</i>
<i>model #:</i>	<i>EK 200</i>	<i>HD 1613/K</i>
<i>voltage:</i>	<i>120</i>	<i>120</i>
<i>watts:</i>	<i>1500</i>	<i>1200</i>

45. How much energy would your hairdryer use in one-half of an hour?

Answers may vary, but if your hairdryer is rated at 1000 watts, the energy used in one-half of an hour would be calculated as follows:

$$\text{Energy} = 1000 \text{ J/s} \times 1800 \text{ s}$$

$$= 1\,800\,000 \text{ Joules}$$

$$= 1\,800 \text{ kJ}$$

$$= 1.80 \text{ MJ of energy}$$

The hairdryer would use 1.80 megajoules of energy in one-half of an hour.

46. How many kilowatt-hours are used by a 100-watt bulb that is on for 10 hours?

A 100-watt bulb that is on for 10 hours uses $100 \text{ W} \times 10 \text{ h} = 1000 \text{ W}\cdot\text{h}$ which equals $1 \text{ kW}\cdot\text{h}$.

47. The word *watts* is written on the top of a light bulb. In terms of brightness, how would you compare a 200-watt bulb to a 40-watt bulb?

A 200-watt bulb should be much brighter than a 40-watt bulb.

48. The bright lights of a city require a great deal of electricity. Why is this essential?

The bright lights of a city are essential due to heavy traffic and pedestrian flow, crime prevention, and the provisions of a visible environment for hospitals and other places of employment.

Section 2: Follow-up Activities

Extra Help

1. Different foods have different amounts of energy. Energy is measured by burning the food to see how much heat is given off. The heat energy is measured in kilojoules (a joule is too small). Use the following food categories to name an example that has a low energy value. Check the tables in the Appendix if you require more help.
 - a. seafood – *poached fish, halibut, sole, trout, shrimp*
 - b. poultry – *skinless roast chicken, turkey*
 - c. fresh berries – *strawberries, blueberries*
 - d. low fat dairy – *yogurt, skim milk*
 - e. gelatin – *sugar-free jelly powders*
2. Energy cannot be destroyed. It has the capacity for doing work and it can be converted from one form to another. Use the list of kinds of energy to do the following:
 - Identify which form is used by each situation.
 - Explain any energy change that takes place.

- | | |
|------------|--------------|
| • light | • electrical |
| • heat | • nuclear |
| • sound | • mechanical |
| • chemical | |

- a. A ballerina dances.

A ballerina dancing uses chemical energy obtained from food.

- b. A tomato plant grows.

A growing tomato plant uses light energy to form chemical energy.

- c. A TV is turned on.

A TV turned on uses electrical energy but converts it into sound and light energy.

- d. A pot of water boils.

A pot of boiling water uses heat energy to produce sound energy.

- e. A power plant produces electricity.

A power plant for electricity may use chemical energy (from coal or natural gas) or nuclear energy to produce sound, heat, mechanical, and electrical energy.

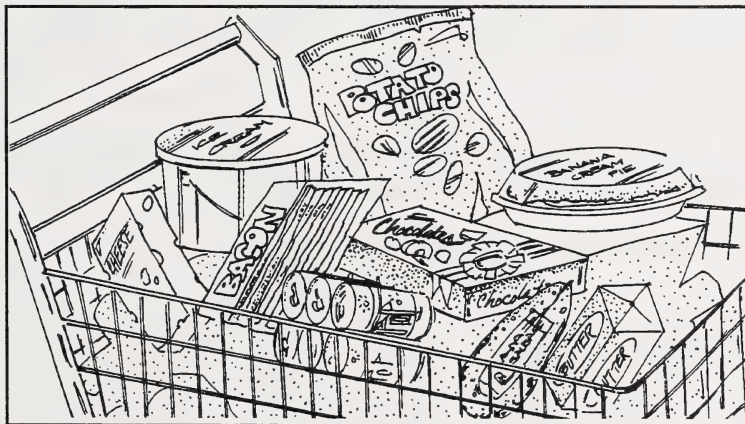
- f. A saw cuts wood.

A saw cutting wood uses mechanical energy to produce heat energy from friction.

- g. A jackhammer works.

A jackhammer working uses electrical or chemical energy (obtained from gasoline) and produces mechanical, heat, and sound energy.

3. Explain why any six of the foods in this shopping cart are high in energy.



Foods high in energy due to a high fat content are cheese, ice cream, bacon, butter, potato chips (fat fried), and banana cream pie; those due to a high carbohydrate or sugar content are the canned pop and chocolate.

4. Which forms of energy can be associated with the sun?

All forms of energy can be associated with the sun.

5. Find the total number of watts that would be used if the two lights and appliances are switched on at the same time in the kitchen. (Hint: Look at the appliance labels to find their wattage rating. Light bulbs have the watts stamped on the glass).

Answers will vary. Appliances in the kitchen may include stove, refrigerator, toaster, kettle, mixer, coffeemaker, blender, waffle iron, popcorn popper, slow cooker, electric wok, frying-pan, can opener, etc. Light bulbs are found on the ceiling, and in the oven, refrigerator, microwave, etc. The total number of watts that would be used is based on the ratings of the appliances or bulbs selected.

- a. What is the total number of watts used in the kitchen?

The total number of kitchen watts is based on the ratings of the appliances or bulbs selected.

- b. How many kilowatts of power does everything use?

Divide the total number of watts by 1000 to get kilowatts of power used.

- c. If you left the four items on for 1 hour, how much electrical energy would be used?

Multiply kilowatts of power used by 1 hour to get the number of kilowatt hours $\text{kW}\cdot\text{h}$ of electrical energy is used.

Enrichment

1. Determine what costs more to run, appliances with heating elements (e.g., toasters, irons, clothes dryer) or those with motors (e.g., mixers, blender, washing-machine).

Answers may vary but could include ideas such as the following:

- *Most appliances with heating elements require constant power, are rated at about 1000 to 1500 watts, and generally consume the most energy.*
- *Motors consume more energy at startup than during their running time.*
- *Cost is based on the length of time the appliance or motor depends on energy and its rating.*

2. Read the electrical meter at home at two intervals and calculate the electrical energy used and its cost. Compare your results with the previous or next power bill.

Answers may vary. Check a previous meter reading as shown on your power bill to determine electrical energy used and its cost.

- Find out how many kilojoules per hour are used in bike riding, walking, running, or swimming.

Use the table in the Appendix to find out how many kilojoules per hour are used in bike riding, walking, running, or swimming.

- Visit your local mall or shopping centre. How many light fixtures are needed in an average shoe or dress store? How many electrical appliances are needed by the store in order to operate? Why?

Answers may vary but could include ideas such as the following:

- Lighting may appeal to prospective customers.*
- Light levels may influence your shopping in a particular store.*
- Merchandise may appear to be a higher quality than it actually is under effective lighting and display.*
- Numerous light fixtures highlight display of merchandise and can be compared with displays having less lighting.*

Section 3: Efficient Energy Consumption

This section deals with identifying the forms of household energy consumption and identifying efficient ways of conserving and using energy.

Section 3: Activity 1

- Name four common examples where large amounts of energy are used for non-essential goods or services.

Answers may vary, but common examples where large amounts of energy are used for non-essential goods or services could include such examples as arcades, luxury resorts, amusement parks, advertising flyers, plastic packaging, manufacture of limousines and luxury cars, and luxury accommodations.

- Name four common examples where fossil fuel energy is used.

Answers may vary, but common examples where fossil fuel energy is used could include cars, planes, trains, producing plastics and chemicals, heating of homes and buildings, factory manufacturing, and industrial processes.

3. Name four common examples where energy is wasted.

Answers may vary, but common examples where energy is wasted could include unnecessary lighting or leaving lights on, printing and distribution of coloured junk mail, and disposable plastic containers, wrappers, and diapers.

4. Why are fossil fuels considered a nonrenewable energy source?

Fossil fuels are considered as a nonrenewable energy source because once they are consumed they cannot be replaced.

5. How many kilojoules of energy do you need each day based on the preceding graph and the energy requirement that most closely describes you?

Answers will vary. The kilojoules of energy you need each day based on the graph depend on your age and sex.

6. Assuming you need 140 kJ/kg of body weight, calculate the kilojoules of energy you need to stay at your present mass.

140 kJ/kg \times _____ (your weight in kg) = _____ kJ

The kilojoules of energy you need to stay at your present mass depends on your weight. If you weigh 60 kg, for example, you would require $140 \text{ kJ/kg} \times 60 \text{ kg} = 8400 \text{ kJ}$.

7. What factors would increase or reduce the number of kilojoules of energy your body needs?

The factors that would increase or reduce the number of kilojoules of energy your body needs depend on your activity, growth, genetic factors, and BMR. You may reduce your energy requirement if you are ill or very inactive. You may increase your energy requirement if you are highly active in sports or strenuous exercise.

8. What sex and age group requires the most energy? Why?

Male teens (15-year-old boys) require the most energy due to muscular development or growth. They also tend to have a higher rate of metabolism than females.

9. What is your basal metabolic rate?

Your basal metabolic rate depends on your weight. For example, if you are 60 kg your BMR is $4.2 \text{ kJ} \times 60 \text{ kg} \times 24 \text{ hours} = 6048 \text{ kJ/day}$.

10. Use the table to calculate your average daily energy output.

Your total energy output depends on the activities you select from the table which are then totalled. Generally, an average 16-year-old male uses 12 000 to 15 000 kJ and a female uses 11 000 to 14 000 kJ.

11. If you plan to lose weight, how would your diet be different?

If you plan to lose weight, your diet would differ in terms of what and how much you eat.

12. If you plan to lose weight, how would your energy output be different?

If you plan to lose weight, some form of exercise would need to be included in your energy output.

13. Use the following table to record the energy you use in a typical day. List all your activities, beginning at midnight and ending at midnight the following day. Use fractions for activities that take less than 1 hour. Space is available to add activities not on the list.

Activity	Time Performed	Energy Burned in kJ
BMR		
sleeping		
dressing, showering		
eating		
standing		
driving		
talking		
schoolwork		
watching TV		
housework		
sports		
dancing		

Your total energy output depends on the activities you select and their energy values.

14. Fill in this table to find your daily energy input. (Multiply by 2, if you have two portions, to get amount of kilojoules.)

Input Energy

Food and Beverage	Amount Eaten	Energy Consumed in kJ

TOTAL kJ = _____

Your total energy input depends on the foods you eat and their energy values.

15. How many kilojoules of food energy did you eat? Are you eating more or less food than you use?

You may be eating more or less kilojoules of food energy than you use. Is your energy input less or more than the output?

16. If you are not gaining weight by taking in too many kilojoules of food energy, can you give a reason why you would be gaining weight?

Some people do not gain weight by taking in too many kilojoules of food energy due to genetic factors or a tendency to burn food faster than others.

17. What other uses in the home depend on hot water?

Other uses in the home that depend on hot water include washing of dishes and clothes.

18. Besides large household appliances, what gadgets in the home consume energy?

Gadgets in the home that consume energy could include such items as a TV, radio, compact disc player, tape recorder, computer, electronic games, and electric scissors, knives, razor, clocks, and pencil sharpener.

19. Which of these appliances are powered by natural gas? Which can also be powered by electricity? Write **G** for gas, **E** for electricity, or **B** for both in the space provided.

Appliance	Energy Power
a. hot water heater	<u> B </u>
b. furnace	<u> B </u>
c. toaster	<u> E </u>
d. garage heater	<u> B </u>
e. clothes dryer	<u> B </u>
f. washing-machine	<u> E </u>
g. lawnmower	<u> E (also gasoline, but not natural gas) </u>
h. stove	<u> B </u>
i. barbecue	<u> B </u>
j. fireplace	<u> B </u>

20. What is the most expensive user of natural gas in your home?

The furnace is probably the most expensive user of natural gas in your home.

21. What do people use to heat their homes in Central Canada where natural gas is not found as commonly as it is in Alberta?

People in Central Canada generally use oil to heat their homes.

22. What two factors affect the amount of electricity used by appliances?

Two factors that affect the amount of electricity used by appliances are the following:

- *the wattage or power rating for each appliance in operation*
- *the length of time they are used*

23. Which appliance uses the most energy per month?

The appliance from the table which uses the most energy is the water heater.

24. a. Choose three appliances from the chart. Fill in the data on the table that follows and calculate the energy used.

Appliance	Wattage	Time used per month	Kilowatt-hours (kW•h)
<p><i>Answers may vary, but if you chose a vacuum cleaner, for example, the watts per month would equal 800 W/mo, the time used per month would equal 8 h/mo, and the kilowatt-hours would be $800 \text{ W/mo} \times 8 \text{ h/mo} = 6400 \text{ W}\cdot\text{h} = 6.4 \text{ kW}\cdot\text{h}$.</i></p>			

- b. Which one of your appliances used the most energy?

Answers may vary, but the appliance using the most energy for the longest time period would have the largest kW•h.

25. Assume you also used 30 kW•h of energy to light your house for one month.

- a. How many kilowatt-hours (three appliances plus lights) did you use in one month?

Add 30 kW•h of energy to the answer you obtain. This gives you the total for one month.

- b. If the utility company charges eight cents per kilowatt-hour, how much did you pay for electricity for the month?

You would multiply eight cents per kilowatt-hour by the number of kW•h you obtained in the previous question.

26. Prepare an observation table in the space provided to record your daily meter readings. Your table should have a title and suitable column headings.

Title: _____

Your table could include the following title and column headings:

Title: Meter Readings Every Twenty-Four Hours for One Week

Time of Reading First Reading in kW•h Second Reading in kW•h Power Used

27. Can you give a reason for a large usage on a particular day?

Any logical reason for a large usage on a particular day is acceptable, for example, an air conditioner may have been used on a very hot day.

28. How many kilowatts were consumed over the 7-day period?

The number of kilowatts that were consumed over the 7-day period are based on your lifestyle.

29. Find out from the utility company how much the electricity costs. See if you can calculate your electric bill based on the power consumed over the 7-day period.

You would multiply the cost of electricity per kW•h by the number of kilowatt-hours plus any additional charges that the utility company uses.

30. Ask your parent, friend, or teacher to show you an electrical utility bill.

Answers will vary. Are you able to locate all the items?

- a. What was the previous month's usage in kilowatts?

The previous month's usage in kilowatts should be recorded on the electrical utility bill.

- b. What is the current month's usage?

The current month's usage in kilowatts should be recorded on the electrical utility bill.

- c. What was the number of kilowatt-hours of electricity that was used?

The number of kilowatt-hours of electricity that was used should be recorded on the electrical utility bill.

- d. What was the power bill for the month?

The power bill for the month should be recorded on the electrical utility bill.

Section 3: Activity 2

1. What probably accounts for the greatest consumption of energy in Alberta? Why?

The heating of homes and buildings is the largest consumer of energy in Alberta due to the cold winters.

2. a. What three areas in your house or school are likely sources for heat loss? How can you tell?

Any three areas in your house or school that are likely sources for heat loss are leaky doors and windows, cracks around foundations, and poor insulation. One way to tell what areas lose heat is to have a professional assessment made, but you may be able to detect drafts or make your own subjective evaluation systematically area by area by using a checklist.

- b. What are possible solutions for the heat losses you identified?

The possible solutions for the heat losses you identified would be to use proven methods and make necessary improvements for areas identified.

3. Examine the sketch to identify at least five areas where energy is wasted. Suggest where the energy is wasted and what the solutions are.

Areas where energy is wasted could include the following:

- *The opened door lets cold air in and warm air out. It should be shut.*
 - *Lights not being used are left on. They should be off.*
 - *No one is watching the TV which is on. It should be shut off.*
 - *The small pot on a large burner is wasting heat and electricity. A smaller element should be used.*
 - *The milk carton is left outside the refrigerator allowing it to warm up. It should be put back into the refrigerator.*
 - *Heat registers are not strategically placed or are in areas of greatest escape. They should be relocated away from windows and entrance ways.*
 - *The coffee pot is plugged in and heated over an extended period. It should be reheated as needed.*
 - *Food on the counter could spoil and be wasted. It should be refrigerated.*
 - *The fridge door is ajar, allowing cold air to escape. It should be shut.*
4. Using the sketch as a guide, suggest five ways in which energy can be conserved through wise or efficient use.

Energy could be wisely used in the following ways:

- *Install storm doors.*
- *Weather-strip doors and windows.*
- *Close window drapes at night.*
- *Insulate walls and attic.*
- *Return beverage containers to depot.*
- *Use the blue box recycling program or encourage its practice.*
- *Turn off lights and appliances when not used.*
- *Recycle kitchen waste into compost.*
- *Keep refrigerator door tightly closed and sealed.*
- *Install double or triple glazed windows.*
- *Maintain household repairs.*
- *Use high-efficiency light bulbs.*

5. Read the statements that follow. Decide if the statement is true or false. If it is false, rewrite it to make it true.

 T a. It is possible in winter to keep my home fairly cool and wear a sweater to keep warm.

 T b. Energy can be conserved by turning off lights and appliances when not in use.

 F c. Incandescent lights consume less electrical energy than fluorescent lights.
Incandescent lights consume more energy.

 F d. Toasting one slice of bread at a time in a toaster does not waste energy.
Toasting one slice of bread at a time in a toaster wastes energy.

 F e. Washing dishes consumes more energy than using throw-away containers, plates, and cutlery.
Washing dishes consumes less energy than using throw-away containers, plates, and cutlery.

 F f. Waterskiing, motorboating, and snowmobiling do not consume much energy.
Waterskiing, motorboating, and snowmobiling do consume a great deal of energy.

 F g. Having your car tuned-up has no effect on fuel consumption.
Having your car tuned-up reduces fuel consumption.

 F h. You would not save money by switching a truck fuel tank to propane.
You would save money by switching a truck fuel tank to propane since propane supplies more energy.

 T i. Energy can be saved by cleaning light bulbs; dirt absorbs light which reduces intensity.

 T j. Taking a shower consumes less hot water than taking a hot bath.

Section 3: Follow-up Activities

Extra Help

1. Assume that your body needs 6 000 kilojoules each day just to live. You played soccer for two hours and watched TV for two hours yesterday. How much energy did you use? (Use the table in the Appendix or in this section to calculate how many kilojoules you used.)

$$\text{Activity in kilojoules} \times \text{time} = \text{kilojoules used}$$

The amount of energy used would equal BMR + energy used in activities.

$$\text{Your BMR} = 6000 \text{ kJ}$$

$$\text{Soccer} = 1160 \times 2 \times 2 \text{ h} = 4640 \text{ kJ (1160 kJ/30 min)}$$

$$\text{TV viewing} = 420 \times 2 \text{ h} = 840 \text{ kJ (420 kJ/hr)}$$

$$\text{Total} = 11\,480 \text{ kJ}$$

2. What are some activities that use a great deal of energy?

High energy activities could include such activities as vigorous swimming, cross-country skiing, soccer, hockey, and running.

3. a. What was the meter reading in kW•h during May?

The meter reading in kW•h during May is 5467 kW•h.

- b. What was the meter reading in kW•h during June?

The meter reading in kW•h during June is 6345 kW•h.

- c. How much electricity was used in one month?

Electricity used in one month is 878 kW•h.

4. Which of the following products or services are excessive energy consumers? Explain.

- delivering pizza
- riding your bicycle to work or school
- drying one shirt in the dryer
- keeping the room temperature at 22°C
- flying a private jet
- using the oven to heat a room
- buying an assortment of cosmetics
- making dinner from raw vegetables
- keeping your car engine tuned-up

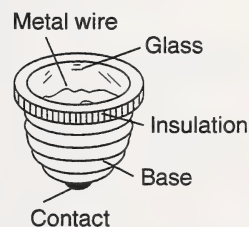
The following products are excessive energy consumers as they represent an extravagant lifestyle:

- pizza delivery
- drying one shirt in the dryer
- keeping the room temperature at 22°C
- energy used at a rock concert
- flying a private jet
- using the oven to heat a room
- buying an assortment of cosmetics

Enrichment

1. Examine how fuses, circuit breakers, or ground fault circuit interrupters (outside or inside bathrooms) operate to prevent an overload of electric current through the circuit.

The fuse has a thin strip of metal that melts at a low temperature when too much electricity passes through the circuit. This breaks the circuit and protects against electrical fires that could result if the current met a high resistance to its flow.



2. Rate a fad diet. Use Canada's Food Guide and the activity chart in the Appendix.

Many fad diets only approximate the essential nutrients but do not contain the requirements obtained from a wide variety of nutrients that a balanced diet provides.

3. a. What is the total amount of energy consumed in one hour by all the fluorescent lights in your classroom? (Hint: A regular fluorescent bulb usually is 40 W.)

Count all the fluorescent lights in your classroom and multiply the number by 40 W by one hour to get watt-hours. Divide this number by 1000 to get kW•h.

- b. If this energy costs eight cents per kilowatt hour, what does it cost to keep all the room lit up during lunch hour?

Multiply the number of kW•h by eight cents per kilowatt-hour to get the cost.

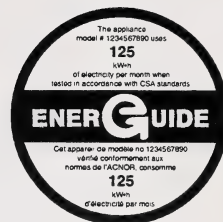
- c. If lights were turned off during lunch hour, what would the school save in one month?

If lights were turned off during lunch hour the saving in one month would be the number of school days in the month multiplied by the number of kW•h by eight cents per kilowatt-hour.

4. Locate the Energy Guide label on three appliances. You may find this easier to do by visiting a store that sells appliances.

Assume you are planning to buy a new refrigerator. Do some comparison shopping to find the most energy efficient model.

Appliances containing the Energy Guide label on them include refrigerators, stoves, dryers, and washing-machines. Your survey should include several different models for a comparison to find the most energy efficient model.



5. Use the Energy Guide on labels of three appliances in your home and calculate the amount of electricity they use in one year. Contact your utility company to find the charge per kilowatt hour and calculate what these appliances cost to use for one year.

Use the energy guide on labels of three appliances and multiply the number of kWh by the charge per kilowatt hour as charged by the utility company to get the cost per kWh. Use the average monthly power rating in the Electrical Appliance Power Rating chart in the module. Multiply this number by the cost per kWh by twelve months to calculate the amount of electricity the appliances use for one year.

6. Compare the cost of operating appliances with heating elements to those with motors.

The cost of running appliances with heating elements is generally higher than those with motors. Initially motors need a surge of electricity to get them running but overall, require less than heating elements. Both need a constant supply of electrical energy.

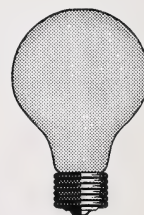
7. Monitor the energy consumption in your home or school for one month. Devise an improved system for using energy in your home or school.

To monitor the energy consumption in your home you would need the cooperation of family members.

To monitor the energy consumption in your school for one month you would need the cooperation of the principal or school board for the information. You would have to devise an improved system for using energy in your school before you approach school officials for this information.

8. Compare the efficiency of 40 W fluorescent and 40 W incandescent lamps in terms of power rating and brightness (lumens). Hold your hand near both after they have been on for 10 minutes to assess which bulb converts more electrical energy into heat energy.

The efficiency of a 40 W fluorescent lamp is about three to four times that of incandescent lamps in terms of brightness (lumens). If both bulbs are 40 W their power rating is the same, but a fluorescent bulb converts less electrical energy to heat energy than does an incandescent lamp. Incandescent lamps become quite hot compared to fluorescent bulbs.



Key to the Assignment Booklet

Section 1 Assignment (30 marks)

- (6 marks) 1. Describe, in detail, the transfer of energy for the meal that the student consumed. Describe where the hamburger and bun, fries, and milkshake got their energy from, and describe each step in the energy transfer.

The hamburger and milk received its energy from a beef animal (cow). The cow got its energy from the grains and grasses which it ate. The energy that the grains and grasses possess originated from the sun and was achieved through the process of photosynthesis. The bun got its energy from the wheat of which it is made and which received its energy from the sun. The fries got their energy from potatoes which in turn got their energy from the sun.

- (10 marks) 2. a. Why is the meal that the student consumed not considered as being a balanced diet? Describe what foods may be added or deleted to make the meal balanced.

The meal is not balanced as it is high in energy (weight gain) but lacking essential vitamins and minerals.

Answers may vary as to what foods need to be added or deleted, but these are a few possible answers:

- *A piece of cheese may be added to the hamburger to give the meal a required milk product.*
 - *Two to four servings of fruits and vegetables of some kind, such as tomatoes, lettuce, or apple, need to be added to make the meal balanced. The vanilla shake could be changed into a fresh banana or strawberry shake for extra nutrition and a better balance.*
- b. Classify or group the types of food that are included in the meal consumed by the student.
- The foods in the meal may be classified as follows:*
- *The hamburger and milk are proteins.*
 - *The bun and fries are carbohydrates.*
 - *The fries, milk, and hamburger also contain fats.*
- c. Explain the role that the process of photosynthesis and respiration played in producing and processing the meal consumed by the student.

Photosynthesis absorbed energy when the food was produced, whereas respiration released energy when the food was consumed.

(4 marks) 3. Use the appropriate letter(s) from the diagram and describe where

- a. the breakdown of starch begins

The breakdown of starch begins in the mouth (labelled A).

- b. the breakdown of protein begins

The breakdown of protein begins in the stomach (labelled D).

- c. glucose is absorbed by the blood

Glucose is absorbed by the blood in the small intestine (labelled G).

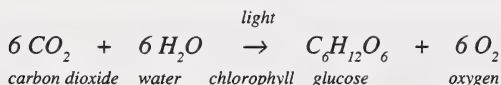
- d. glucose and oxygen undergo respiration in a muscle

Glucose and oxygen undergo respiration in a leg muscle (labelled I).

(4 marks) 4. Write a word equation that describes the following. Be sure to include the energy source in your answer.

- a. photosynthesis

Photosynthesis is a process by which green plants produce carbohydrates and oxygen from carbon dioxide and water in the presence of light and chlorophyll.



- b. respiration

Respiration is a process in which animals release energy, carbon dioxide, and water by reacting carbohydrates and oxygen in body cells.



- (6 marks) 5. If you were in charge of planning a nutritious balanced meal for a young adolescent's weekend camping trip, what would your menu include for lunch? Select the actual foods that would be included in your menu and explain what standards were used to choose them.

Answers may vary as to what foods would be included in the menu for a nutritious balanced meal, but if Canada's Food Guide is used to make the selection, then a few possible answers could include items from the following daily allowances:

- *2-3 servings of meat and alternatives, such as 50 to 100 g cooked lean meat, fish, liver, or poultry, 30 mL peanut butter, 1 or 2 eggs, 250 mL cooked dried peas, etc.*
- *5-10 servings of fruits and cooked or raw vegetables from a wide variety of selections*
- *5-12 servings of grain products such as whole grain or enriched breads or pastas*
- *3-4 servings of milk and milk products such as 250 mL milk, 50 g cheddar or process cheese, etc.*

Section 2 Assignment (45 marks)

- (10 marks) 1. a. Marc drinks four cups of coffee with sugar a day. Why should Marc drink coffee without sugar?

The sugar in the coffee adds unnecessary energy. The four cups of coffee with sugar would add about 4×400 kJ or 1600 kJ of extra energy.

- b. How much energy does Marc consume in a lunch consisting of a double cheeseburger, hot fudge sundae, and two colas?

The energy consumed at lunch is 2200 kJ for the double cheeseburger plus 2300 kJ for the hot fudge sundae and 600 kJ for the colas or 5100 kJ in total.

- c. How much energy does Marc consume in a supper consisting of three pieces of fried chicken, french fries, and a milk shake?

The energy consumed at supper is about 4200 kJ for the fried chicken plus 1000 kJ for the french fries and 1300 kJ for the milkshake or about 6500 kJ in total.

- d. Marc has a habit of including desserts with every meal. How much food energy is taken in if a hot fudge sundae, chocolate bar, date square, and caramels were included as desserts during the day?

The energy consumed as desserts is about 2300 kJ for the hot fudge sundae plus 650 kJ for the chocolate bar plus 1600 kJ for the caramels plus 800 kJ for the date square or about 5350 kJ in total.

- e. What was Marc's total energy consumption for lunch, supper, desserts, and coffee which he consumed during the day?

The total energy consumed during the day was about 1600 kJ for coffee, 5100 kJ for lunch, 6500 kJ for supper, and 5350 kJ for desserts or about 18 550 kJ in total.

- (4 marks) 2. a. Approximately how many Calories are in Marc's hot fudge sundae? Show your calculations.

The energy in a hot fudge sundae is approximately 500-600 Calories. The calculation is as follows:

$$\text{follows: } \frac{2300 \text{ kJ}}{4.2 \text{ kJ/Calorie}} = 548$$

- b. Based on your answer of Marc's total daily energy consumption, will Marc gain or lose weight?

If the total energy consumed during the day was about 18 550 kJ, Marc would gain weight because his daily requirement is only 13 000 kJ.

- (2 marks) 3. Explain why a 40 W fluorescent bulb is more efficient than a 40 W incandescent bulb.

A 40 W fluorescent bulb is more efficient than a 40 W incandescent bulb because it gives more lumens per watt. A 40 W fluorescent bulb has 33 to 77 lumens per watt compared to only 8 to 25 lumens per watt for an incandescent bulb.

- (4 marks) 4. a. What amount of electrical energy in watts or J/s does a 110 V coffeemaker use if it requires 8.2 A of electricity? Show your calculations.

The coffeemaker will use the following amount of energy:

voltage \times ampere = power

$$110 \text{ V} \times 8.2 \text{ A} = 902 \text{ W or } 902 \text{ J/s}$$

- b. What amount of electrical power in kJ or kW does the 110 V coffeemaker use in 30 minutes if it requires 8.2 A of electricity? Show your calculations.

The coffeemaker will use the following amount of energy:

$$\text{power} = 902 \text{ J/s}$$

$$\text{time} = 30 \text{ min} \times 60 \text{ s/min} = 1800 \text{ s}$$

$$\text{energy} = 902 \text{ J/s} \times 1800 \text{ s}$$

$$= 1\,623\,600 \text{ J}$$

$$= 1624 \text{ kJ}$$

or

$$1624 \text{ kJ} / 3600 \text{ kJ/kW} = 0.45 \text{ kW.}$$

- (2 marks) 5. Which appliance uses more power in one hour, a 220 V washing-machine that uses 2.8 A of electricity or a 110 V washing-machine that uses 4.9 A of electricity? Show your calculations.

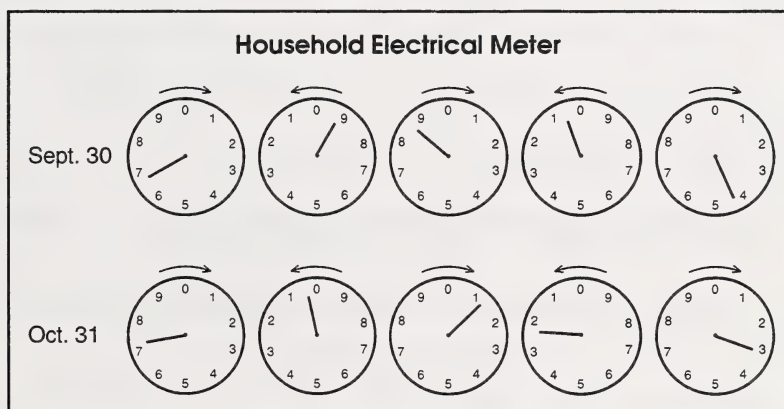
The first washing-machine uses power = $220\text{ V} \times 2.8\text{ A} = 616\text{ W}$. The second washing-machine uses power = $110\text{ V} \times 4.9\text{ A} = 539\text{ W}$. The difference is $616\text{ W} - 539\text{ W} = 77\text{ W}$. The first washing-machine has more power.

- (3 marks) 6. If you needed to buy a light bulb to use for reading, what wattage would you choose? Explain why.

A 60 W bulb is adequate. Higher wattage results in costlier energy and a glare when you are reading.

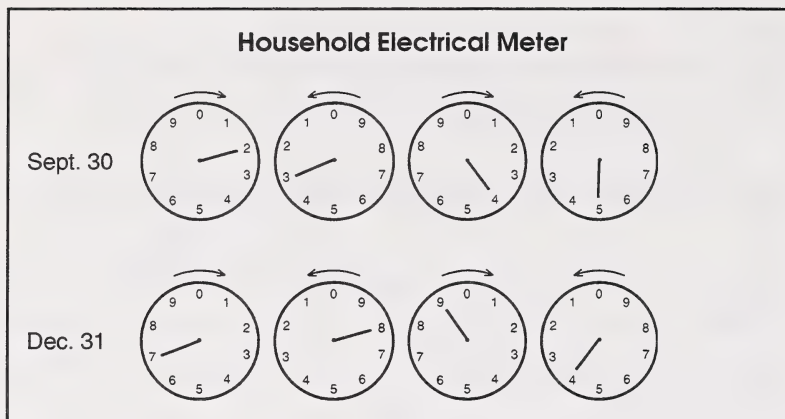
- (4 marks) 7. Read the following household electrical meters to calculate the power consumption for the following situations:

- a. an urban home during the month of October



The reading on September 30 is 69 804 and 70 123 on October 31. The power used is $70\,123 - 69\,804$ or $319\text{ kW}\cdot\text{h}$.

- b. a rural farming operation during a three-month period



The power used for the three month period is $7894 - 2345 = 5549 \text{ kW}\cdot\text{h}$.

- (3 marks) 8. a. What is the total amount of energy in kilojoules that Rhona consumes in one day?

The total energy that Rhona consumes in one day is about 11 480 kJ.

- b. If Rhona's BMR is 5000 kJ, calculate her expenditure of energy per day.

The total energy that Rhona uses in one day is about 11 025 kJ. This is the total of 5000 kJ for her BMR, 2540 kJ for walking, and 3150 kJ for sitting.

- (7 marks) 9. a. According to your energy requirement table, how much energy does Rhona need to maintain her body weight?

Rhona requires about 7900 kJ of energy to maintain her body weight.

- b. Will Rhona gain or lose weight? Why?

Rhona will gain weight as her intake is 455 kJ of excess energy compared to her output or what she uses.

- c. Discuss whether Rhona's diet includes the foods as recommended by Canada Food Guide.

Rhona has the correct serving of milk products. She had two servings of meat, both of which are high energy selections. She has half the correct amount of breads and cereals and the cinnamon buns are a high energy selection. She has the correct number of fruit and vegetable servings.

- d. What changes should Rhona make?

Overall, Rhona has to increase her intake of grain products. She should make leaner and lower-fat choices for some of her selections. Rhona could substitute skim milk for whole milk to reduce her energy intake and still obtain the minerals her body requires. She could substitute fish, eggs, or poultry for the meat servings for less energy intake. Breads and cereals could replace the high energy cinnamon buns.

- e. If Rhona were to go dancing on a Saturday night for three hours, how much energy would she use?

Dancing would use $3 \text{ h} \times 27.0 \text{ kJ/h} \cdot \text{kg} \times 57 \text{ kg} = 4617 \text{ kJ}$ of energy.

- (2 marks) 10. A colour television uses 350 W of energy. Assuming you watch colour television for three hours a day, seven days a week, calculate the number of kW•h your viewing consumes.

Watching coloured television for this amount of time would use 7.35 kW•h of energy.

time = $3 \text{ h/d} \times 7 \text{ d} = 21 \text{ h}$ power = 350 W

energy = power \times time

= $21 \text{ h} \times 350 \text{ W}$

= $73\,500 \text{ W} \cdot \text{h}$

= $73.5 \text{ kW} \cdot \text{h}$

- (4 marks) 11. Explain the energy transfers that occur in any **two** of the following situations:

- An adult pushes a gasoline lawnmower.
- Thunder follows lightning.
- Teenagers frequently listen to portable stereo music.
- Plants are able to grow inside a greenhouse.

Mechanical kinetic energy of the adult is obtained from chemical food energy which receives its energy from the sun through photosynthesis. Chemical energy in gasoline is converted into the mechanical kinetic energy of the lawnmower.

The sound energy of thunder results from the discharge of lightning, a form of electrical energy which is converted into light and heat energy.

Stereo music results in sound energy produced by electrical energy from the chemical energy of batteries and radio waves.

Radiant solar energy is absorbed by the glass and changed into light and heat energy inside the greenhouse. This is absorbed by plants and stored as chemical energy.

Section 3 Assignment (25 marks)

(10 marks) 1. For each of the following activities that you plan in your checklist, suggest an energy efficient substitute or alternative.

- a. Send out embossed invitations.

Invitations can be made by telephone or in person.

- b. Have the food prepared by a caterer.

Food can be prepared at home.

- c. Serve steak, artichokes, or lobster.

Use locally available produce and meats. Due to limited supply and transportation costs, lobster is more expensive than fish. Steak is more expensive than roast beef.

- d. Use disposable plastic plates, cups, and cutlery.

Disposable plates and cutlery use a nonrenewable energy source to produce and create disposal problems because they are nonbiodegradable. Use ceramic plates which can be washed and used again.

- e. Remember to wash your silk shirt on the day of the party.

Hot water and electricity are wasted by washing a small load of laundry. It takes the same amount of energy to wash a full load and the shirt could be included with other laundry.

- f. Take a long hot bath before guests arrive.

A shower uses less hot water than a bath.

- g. Turn on all lights to welcome guests.

Turn on the lights only in the rooms the guests will be using. Less lighting can sometimes be used effectively to create a pleasing atmosphere.

- h. Rent a new compact disc player and a large-screen TV.

Use an existing stereo, radio, or TV, have a singsong, or play games instead.

- i. Put on lots of makeup.

Don't use makeup or expensive cosmetics that come in extravagant throw-away packaging.

- j. Go snowmobiling or water-skiing.

Activities that rely on fossil fuels and pollute the environment can be replaced with a toboggan slide, a hayride, sailboating, or canoeing.

- (3 marks) 2. Justify why a household needs more than one TV set.

Answers may vary but could include the fact that it is difficult to justify two TVs in a household because it represents an extravagant lifestyle. Having one TV presents an excellent opportunity for family members to reach a compromise as to which program will be watched. It may also make them more selective about the choices available.

- (4 marks) 3. Which two appliances could a household do without? Why?

Answers may vary but could include appliances that are nice to have but may be somewhat extravagant luxuries such as air conditioners, hot tubs, saunas, etc.

- (2 marks) 4. Is the cost of household insulation worth the investment? Why?

Answers may vary but could include the fact that walls and the roof are major contributors to heat loss. In the long run, it's more costly to heat a home where large heat losses occur than it is to insulate the house and reduce heat loss.

- (2 marks) 5. Explain how you could contribute to a waste of energy.

Answers may vary but could include answers such as the use of a car for short trips, unnecessary use of lights and appliances, use of disposable plastic products, failing to close doors after oneself, leaving the TV on when nobody is watching it, etc.

- (4 marks) 6. Suggest or devise a simple energy efficient model to reduce waste.

Answers may vary but could include answers such as repairing and weatherstripping leaking doors and windows, lowering the thermostat, maintaining the furnace, upgrading of existing insulation, use of car pools, tuning the car regularly, recycling versus discarding waste, using a blue box or recycling type of waste management, returning containers to a bottle depot, etc.

SCIENCE 24

Module 8: Energy Forms



Learning Facilitator's Manual



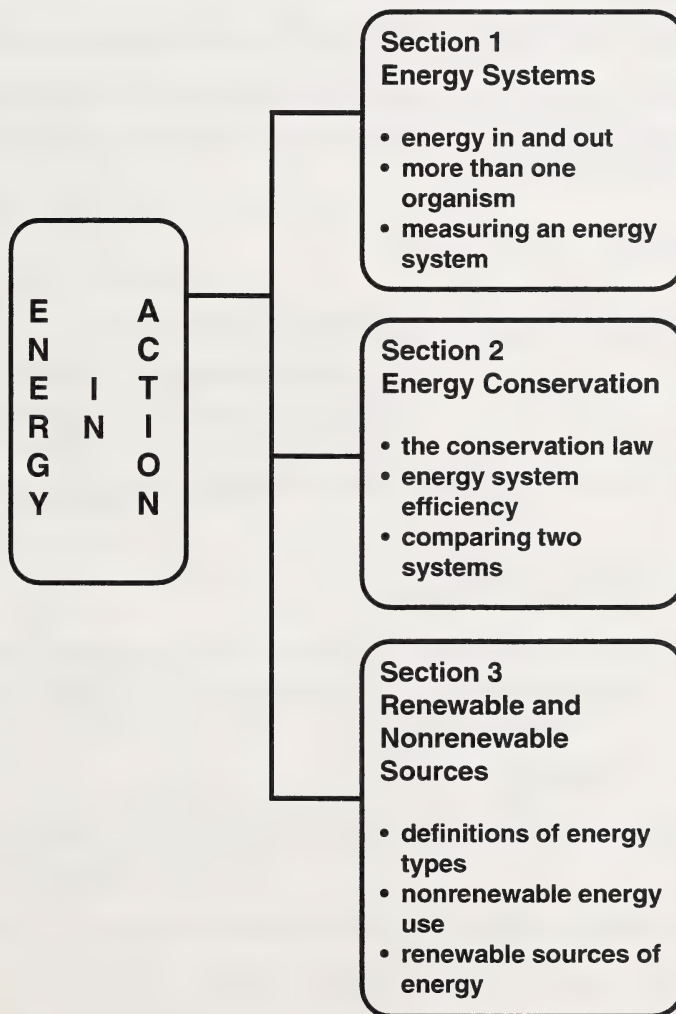
**Distance
Learning**

Alberta
EDUCATION

Module 8: Energy in Action – Overview

This module builds on the foundation of Module 7. It uses the basic ideas of energy flow and discussion of energy systems. The energy components within a system include input, conversion, and output.

The student should develop an awareness of energy conservation and alternate energy sources. Renewable and nonrenewable energy sources are identified and described. Since efficiency of an energy system can be calculated, energy consumption can be improved as well.



Materials and Equipment

No special materials are necessary to complete the investigations in Module 8.

Possible Media

Video Series *Ring of Truth*. ACCESS Network.

Suggested Enrichment Activities

- A field trip to Syncrude, Suncor, or any oil or coal plant would be applicable.
- Design an energy rally project to end the module. The students are given a certain quantity of energy (for example, 1 000 000 J) and they must travel a certain route like in a car rally to consume it.

Evaluation

The evaluation of this module will be based on four assignments:

Section 1 Assignment	30 marks
Section 2 Assignment	35 marks
Section 3 Assignment	<u>35 marks</u>
TOTAL	100 marks

Section 1: Energy Systems

Section 1 serves as an introduction to the concept of an energy system. Examples of mechanical and biological energy systems are given. The section also provides an introduction into energy consumption, conversion, and methods for measuring energy components.

Section 1: Activity 1

1. Identify the three parts of an energy system shown in the illustration of energy flow in the human body.

input energy: *food or chemical potential energy*

energy conversion: *digestion, cellular respiration*

output energy: *running or mechanical energy*

2. What elements make up carbon dioxide and water?

carbon, oxygen, hydrogen

3. Name the three parts of an energy system represented in photosynthesis.

input: *solar energy, chemical energy from CO_2 , H_2O*

conversion: *a chemical reaction or rearranging the elements*

output: *chemical potential energy in the glucose molecule*

4. Name the components of the energy system shown in the illustration of the steam engine.

input: *burning coal (chemical energy) turns to heat*

conversion: *chemical energy from coal turns to heat to boil water*

output: *steam – heat energy (and pressurized)*

5. Explain how Hero's engine works.

The water boils and steam escapes through the nozzles. A rocket effect makes the whole ball spin in the opposite direction as the escaping steam.

Section 1: Activity 2

1. a. Fill in the following chart showing the energy input and output for the cow and the person.

	Input	Output
cow	grass	milk, tissues, movement, etc.
person	carrot, steak	healthy body, energy to move

Note: Inputs and outputs are relative to a particular organism.

- b. What is the original energy input?

The sun is the original energy input.

2. Identify the energy system parts shown in the car.

input: *gasoline (and battery)*

conversion: *gas is burned to release heat energy*

output: *mechanical energy (the car goes)*

Section 1: Activity 3

1. a. Where has the extra (or lost) energy gone? (Hint: It's heat energy too.)

Heat is lost to the air and in heating the beaker and stand.

- b. What percent of the input energy ends up in the water as output energy?

$$\frac{29.2}{40} = \frac{n}{100} \quad n = 73\%$$

The output energy is 73% of the input energy.

2. a. Suppose a machine does 500 J of work after you put 1000 J of energy into it. Calculate its efficiency.

$$\frac{\text{output}}{\text{input}} = \frac{500}{1000} \times 100 = 50\%$$

The machine has a 50% efficiency.

- b. A car is 50% efficient (that's excellent for a car). If you get 100 000 000 J of work out of it, how much energy was put into it?

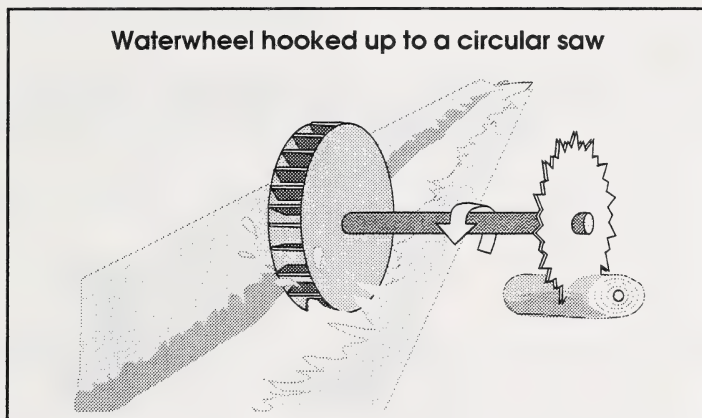
You put in 200 000 000 J of energy (because $\frac{100}{200} = \frac{\text{output}}{\text{input}} = 50\%$).

Section 1: Follow-up Activity

Extra Help

1. Label the input, conversion, and output in these systems:

a.

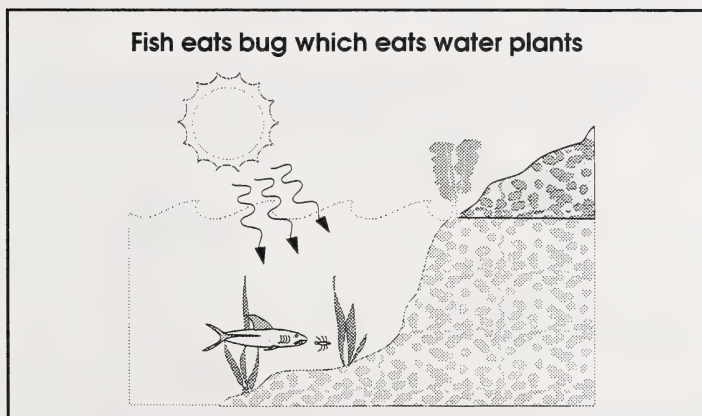


input: *water falls (gravitational energy)*

conversion: *wheel (and axle) turns (gravity mechanical)*

output: *saw cuts wood*

b.



input: *the sun (photosynthesis starts all food chains)*

conversion: *plants convert solar energy to food (glucose)*
bug converts plant to its body (protein)
fish converts bug protein

output: *fish health and motion*

2. If you put 60 J of energy into a system and got 15 J of energy out, what would the efficiency of the system be?

$$\text{Efficiency} = \frac{\text{energy output}}{\text{energy input}} \times 100 = \frac{15 \text{ J}}{60 \text{ J}} \times 100 = 25\%$$

The efficiency of the system would be 25%.

3. Suppose you do 500 J of work pushing a box up a ramp. If you could lift the box straight up instead and doing this would require only 400 J of work, then how efficient is the ramp?

$$\text{Efficiency} = \frac{\text{work output}}{\text{work input}} \times 100 = \frac{400 \text{ J}}{500 \text{ J}} \times 100 = 80\%$$

The efficiency would be 80%.

(If you have trouble remembering which number goes on top, remember that efficiency must be less than 100%).

Enrichment

1. How efficient are automobiles? Are bicycles more or less efficient than automobiles? You may have to research this.

Try contacting an engineer. Bicycle magazines are good too. Automobiles are about 20% efficient. Bicycles are more efficient.

2. If a device were 100% efficient, then output energy would equal input energy, and, once started, the device would work forever. Such a device is called a perpetual motion machine. Try to design one.

The idea of perpetual motion can be seen in the prints of Maurits C. Escher. You may want to take a look at his prints.

Section 2: Energy Conservation

Section 2 explains and defines the law of the conservation of energy. It gives a continued exploration of energy efficiency and illustrates ways to improve and compare energy systems.

Section 2: Activity 1

1. a. What happened when you added the baking soda?

The mixture began to fizz or bubble.

Section 2: Activity 1

1. a. What happened when you added the baking soda?

The mixture began to fizz or bubble.

- b. How much did the weight change?

The weight (or mass) did not change much at all. (If you used the balance, it may seem heavier because you moved the position of the baking soda.)

2. Look at these systems and explain where the lost energy is. Remember, it's still there but not useful for the purpose of the energy system.

a.



- consumes 8000 kJ of energy each day
- gets about 2000 kJ of mechanical energy out of it

Missing energy is heat produced by the body systems. This heat must be eliminated (e.g., sweating).

Note: It takes 2268 kJ to evaporate 1 kg of water.

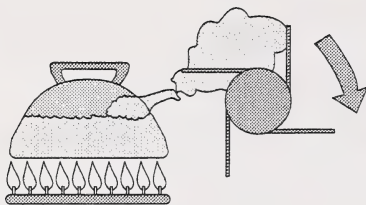
b.



- A person eats a piece of chicken and gets 500 kJ of energy from it.
- The chicken ate several times as much energy to produce the leg.

The chicken's body produces heat too. Also the chicken's body takes a year to mature and it produces nonedible parts. Only 10% of the energy the chicken ate is used for its body parts.

c.



- one million joules of heat energy is used to boil the water
- a tiny fraction of that turns the wheel

Some heat escapes into the air before it gets into the water. The steam spreads out taking its heat energy away from the wheel. Friction in the wheel causes it to heat up.

Section 2: Activity 2

1. Consider the following systems and rate them as low or high efficiency.

- a. an ox-driven plough on farmland

low – You must feed the ox continually, and a plough loses energy to friction.

- a. a person on a bicycle travelling 15 km/h for one hour

high – The person uses about 1500 kJ of energy to ride the bicycle.

- c. an electric light bulb

low – It is 20% efficient.

- d. a plant making food from sunlight

low – A plant converts about 4-7% of the light energy into glucose during photosynthesis.

2. Multiply the number of seconds it took to boil the water by 2500. This is the input energy.

If it took 3 min 45 s, then that is $3 \times 60 = 180 + 45 = 225$ seconds, so $2500 \times 225 = 563\,000$ J or 563 kJ.

3. a. Subtract your starting temperature from 98°C to find the temperature change.

For example, if your cold water was 21°C , you would take $98^{\circ} - 21^{\circ} = 77^{\circ}$ for the change in temperature.

- b. To find the useful energy output use the following formula.

$$4.2 \text{ J/g} \cdot ^{\circ}\text{C} \times \Delta t \times 500 \text{ g}$$

Using the previous calculations as part of your data, this would be the calculation for useful energy output.

$$\text{Energy} = 4.2 \text{ J/g}^{\circ}\text{C} \times 77^{\circ}\text{C} \times 500 \text{ g} = \text{about } 162\,000 \text{ J or } 162 \text{ kJ}$$

- c. Find the efficiency from the following formula: $\frac{\text{output energy}}{\text{input energy}} \times 100$

$$\text{Efficiency is } \frac{\text{output}}{\text{input}} = \frac{162 \text{ J}}{563 \text{ J}} \times 100 = 29\% \text{ using the previous calculations.}$$

3. a. No stove is 100% efficient. Name two places where energy that is not useful has gone.

- *Heat is lost to the air (stoves heat the kitchen too).*
- *The element lights up a dull red (light doesn't heat water).*
- *Water evaporates and carries heat into the air.*
- *The stove heats the pot and itself too.*

- b. Suggest two ways that the system could be improved (ways to boil water faster).

- *Cover the pot.*
- *Put aluminum foil around the burner to reflect heat back to the pot.*
- *Try a lighter pot (or a smaller one).*

4. a. Why do you have to run for 12 min instead of a shorter sprint?

The longer run makes you use all the stored up chemical energy in your cells. A sprint just uses some of this chemical energy.

- b. How can you improve the efficiency of your aerobic system?

The efficiency can be improved only by exercising. If you want your aerobic fitness to improve, you have to exert it. That means exercising until you are really out of breath, three times a week, for 15 min each time.

Section 2: Activity 3

1. Look at the previous chart. For each task, write down the method that you think is most energy efficient.

- a. boil water

The kettle is more efficient for boiling one litre of water. It does the job in a fraction of the time the microwave does, so it uses the least energy. (This takes into account the different wattage of the two devices.)

- b. get protein

The soybeans are the most energy efficient. Each stage of a food chain results in a loss of energy. Eating plants directly uses the least energy.

- c. go to the store

Walking is the most energy efficient since it uses 16.2 kJ of energy per hour. Burning gasoline uses millions of joules of energy per litre.

- d. produce electricity

Hydroelectricity is the more efficient. Hydroelectric stations are about 90% efficient. Solar cells are only about 5-10% efficient.

2. What do you think is the most energy efficient way to transport goods long distance?

Write your prediction here.

Your answer will vary since it is only a prediction.

3. List one advantage of using each transportation type.

- a. semitrailer – *It's fairly fast and delivers close to or at a company's doorstep.*
- b. plane – *It's very fast. It's expensive, but sometimes speed is more important.*
- c. train – *It's the least expensive, but it takes longer and you have to go to the train station for the goods.*

4. a. Why is a train a high efficient user of energy?

The train carries a great deal of freight at a time. It travels on level ground almost all of the time.

- b. Why is a semitrailer truck an adequate user of energy?

It uses more energy to go faster than the train. It carries less freight at a time.

- c. Why is an airplane an inefficient user of energy?

Energy efficiency is sacrificed for speed. It takes a great deal of energy to lift a heavy load. Jumbo jets are better – they carry more.

Section 2: Follow-up Activities

Extra Help

1. A car engine gets so hot when in use that an entire cooling system is needed to prevent it from melting. The gasoline not only supplies the energy to move the car but it must run a water pump for the cooling system as well. Give two reasons why a car engine gets so hot.

- *The gas is being burned at high temperature.*
- *Friction between the moving parts of the engine produces heat.*

2. a. Suppose you are a vegetarian. What percent of the sun's energy do you get from your food?

You can only obtain 4-7% from food because that's the efficiency of photosynthesis.

- b. If 10% of the food you eat is muscle and fat, what percent of the sun's energy is transformed into your body?

*The percentage of the sun's energy transformed into your body is 10% of 7% (or 7/10 of 1%).
Note: This is one step of the food chain.*

- c. If you eat a cow (steak) and the cow eats grass, what percent of the sun's energy is transformed into your body?

Ten percent of the answer for b. (or 7/100 of one percent) is transformed into body energy.

3. Match the energy comparison unit with the system it is used for.

Energy System	Unit for Comparison
<u>iii</u> a. generating electricity by burning coal	i. energy per passenger•kilometre
<u>i</u> b. car travel	ii. kilograms per hectare•year
<u>ii</u> c. yield of wheat crop	iii. watts per tonne

Enrichment

1. A Boeing 767 is one of the most efficient airplanes around. Do some research on efficiencies of airplanes. How good is a four-seater Cessna?

A powerful engine was developed soon after airplanes became commonplace. Efficient airplane design wasn't needed until things like the energy crisis of the 1970s.

2. Can vegetarians get all the protein and vitamins they need? If so, from which plants can they get them?

Yes, you can get all your nutrients but you have to know how. Plants such as beans provide protein.

3. Do some research on energy expenditure of mammals. Which mammal uses the least energy? Which mammal uses the most energy?

Research a shrew, a person, and a whale. Also try a small bird.

Section 3: Renewable and Nonrenewable Resources

Section 3 explains and gives examples of renewable and nonrenewable resources. The pros and cons of each energy type are discussed. An energy-reducing strategy for both energy sources is examined.

Section 3: Activity 1

1. Classify the following energy sources as nonrenewable or renewable.

- a. windmills: *renewable*
- b. coal: *nonrenewable*
- c. solar: *renewable*
- d. nuclear: *nonrenewable*
- e. wood: *renewable (if you're careful about replanting)*

2. Look at the list of nonrenewable sources. On which of these energy sources does Alberta's economy depend?

oil, natural gas, coal, nuclear power

3. How will this affect Alberta's economy?

Alberta will sell less energy but the deposits will last longer.

4. Look at the list of renewable sources. On which of these energy sources does Alberta depend?

Alberta is too far from the equator to use an extensive amount of solar energy. Some windmills are working in southern Alberta. A few small hydroelectric stations exist. Alberta also depends on the biofuels.

Section 3: Activity 2

1. Name two positive aspects and two negative aspects of nuclear energy.

Positive aspects could include the following:

- *very concentrated, fuel goes a long way*
- *a good substitute if no other sources are around*
- *economically feasible*

Negative aspects could include the following:

- *radiation*
- *waste* } *very hard to shield and store radioactive energy*
- *used for nuclear weapons*

2. Name two positive aspects and two negative aspects of fossil fuels.

Positive aspects could include the following:

- *easy to get*
- *fairly concentrated energy*
- *extremely versatile – makes hundreds of things*
- *found here in Alberta*

Negative aspects could include the following:

- *many pollutants from burning (acid rain)*
- *oil spills*
- *greenhouse gases*

3. a. Where do most of the pipelines go to? (They come from oil and gas fields.)

Pipelines go to seaports (Vancouver, Prince Rupert), to Eastern Canada, and to the United States.

- b. Up in the Beaufort Sea there is a huge off-shore oil and gas area. Why develop this in such a cold climate? Why not develop alternate energy sources?

It's more economic for oil companies to go find energy sources to get oil the hard way than to develop the new technologies for alternate energy sources. Note: It's easier for a large company to make money selling high-grade energy. Low-grade energy must be decentralized to be efficient.

- c. British Columbia has many more hydroelectric stations than Alberta. (The stations are larger too.) Why?

British Columbia is mountainous. Therefore, there is more water runoff in British Columbia. Alberta is mostly prairie or flatland.

- d. Look at where the coal-fired plants are on the second map and the coal mining areas on the first map. What can you say about where the coal-fired plants are?

The coal-fired plants are located beside coal mining areas. This reduces transportation costs.

Section 3: Activity 3

1. a. Why is Alberta **not** a good place to depend on a solar-heated house?

The sun is very low in winter in Alberta. It might not keep the house warm.

- b. What advantage is there to having a solar collector in Alberta?

A solar collector will reduce energy costs. The gas furnace will come on less often.

2. a. Why is there a massive brick wall near the sun room?

The brick heats up all day and helps keep the house warm at night. (It's a way to store heat for later.)

- b. If the hot water pipes are connected from the hot water tank to the collectors, what effect will this have on a sunny day?

The water in the collectors will get very hot so less gas is used by the hot water heater.

- c. What is a major problem with using the solar collector panels in the winter?

Water pipes might freeze and burst. They will cool the water in the tank and cause more gas to be used by the hot water heater.

- d. How useful is the windmill?

Windmills will make electricity now and again. It's probably not worth the cost to build it.

- e. Something not drawn in the diagram is crucial to the system. It prevents heat from escaping. What is it?

Insulation is crucial to an energy system. Note: This is the most inexpensive way to save energy.

3. a. Why would a farm have a greenhouse?

A greenhouse could grow vegetables all year.

- b. Solar panels circulate cold liquid into the panels and hot liquid out of the panels. If the liquid was sent past hot water pipes, what effect would it have on the pipes?

The hot liquid would heat the hot water pipes. This lessens the load on the hot water heater.

- c. How useful is the windmill? It is connected to a storage battery. (It keeps the battery charged up.)

A windmill this size would be helpful to offset the cost of electricity.

- d. A **methane digester** takes animal and human wastes and turns them into sludge and methane gas (natural gas). Why is it advantageous for a farm to have a methane digester?

A farm has many animals contributing to the digester. A large amount of methane can be recovered. Sludge can go on crops as fertilizer.

Section 3: Follow-up Activities

Extra Help

1. Indicate whether the following statements are true or false. If the statement is false, rewrite it to make it true.

False a. Oil is a renewable resource.

Oil is not a renewable resource; there are only limited amounts of this fossil fuel.

True b. Wood is a renewable resource.

Wood can be renewable only if the trees are replanted.

False c. Natural gas is a low-grade (not very concentrated) energy source.

Natural gas is a high-grade energy source (higher than gasoline).

True d. Alberta has no major uranium deposits for nuclear energy.

False e. Solar energy is nonrenewable.

The sun will always provide an available source of energy.

2. Fill in the following chart.

Oil and Gas Energy	
find it	<i>oil exploration (check geology of rocks)</i>
extract it	<i>use oil platforms at sea or oil derricks pump oil out</i>
deliver it	<i>pipelines, tankers (ships), truck, train</i>
convert it	<i>refineries turn crude oil into gasoline, diesel, etc.</i>
clean up	<i>oil spills, gas well blowouts, acid rain, pipeline leaks, car exhausts</i>

3. a. Name three things anyone could do to conserve energy.

Some example answers are given:

- *Turn appliances and lights off when not in use.*
- *Ride a bike for short trips.*
- *Car pool.*
- *Keep car in good running shape.*
- *Insulate your house well.*

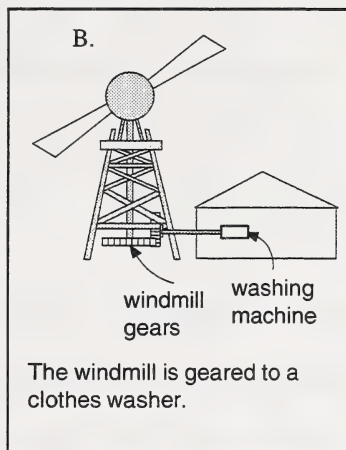
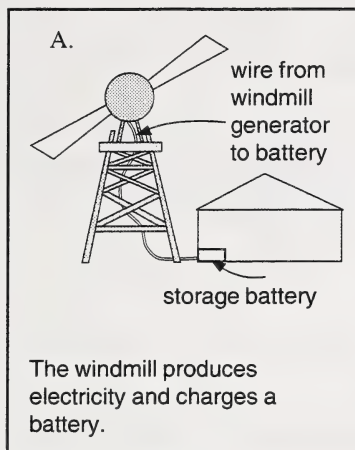
b. The fuel consumption of a car changes only a tiny bit when four people are in the car as compared to when one person is in it. In terms of energy conservation, how can you best use a car?

Plan fewer trips and have more people in the car when making trips.

c. If the temperature was -40°C and the weather was sunny, how efficient would a solar house be?

A solar house is good. The sun will heat the house even at -40°C provided it's well insulated. (How warm is the inside of a car parked outside in the sun at -40°C ?)

4. From the following two set-ups, pick the one that you think is best. Explain why you chose as you did.



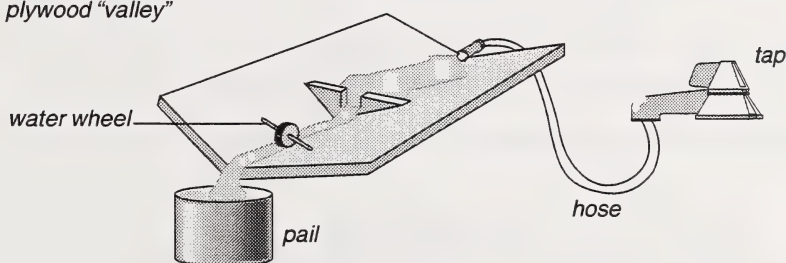
Choice A is the best set-up. You can use the battery anytime. When the wind blows, it gets charged (day or night).

Enrichment

1. Build a model of a hydroelectric dam.

Here are a few ideas:

plywood "valley"



2. Research acid rain. Is Alberta in danger of being affected by acid rain?

Alberta is fairly protected against acid rain. It doesn't have the industrial emissions from burning coal or the industries that produce it as some heavily industrialized areas do.

3. Electric cars are relatively new. Research them and look for their advantages and disadvantages.

Electric cars are designed for short trips, they need to have their batteries recharged, and they are less efficient than conventional cars. They are pollution-free and environmentally friendly.

4. Look up methane digesters to find out how they work.

Methane digesters are common to large urban waste-water treatment plants. Anaerobic bacteria decomposes solid waste into methane or biogas, carbon dioxide, and hydrogen sulfide (rotten egg gas). The same process is involved in rural farms where manure is decomposed. The gas is used as a fuel and the remaining sludge is spread on farmland as fertilizer.

Key to the Assignment Booklet

Section 1 Assignment (30 marks)

- (6 marks) 1. Choose **one** of the energy systems and explain the following:

- What kind of energy is involved? (energy input)
- What changes in energy occur? (energy conversions)
- What kind of energy is involved? (energy output)

Explain where the components (parts) are by using words or diagrams to help your explanation.

The various energy systems may be explained as follows:

Piano

- The energy input is the muscles of fingers pushing on keys.*
- Some energy conversions that take place are the following:*
 - muscles (finger motion) into key motion*
 - keys pivot and send a hammer into strings*
 - hammer (motion) causes strings to vibrate (another motion)*
 - string vibrates air to make a sound*
 - sound is amplified by a sound board*
- The energy output is sound energy.*

Car

- The input energy includes the muscles of the hand turning the key, and the energy stored in the battery and the gasoline is also input energy.*

b. *The energy conversions include the following:*

- *muscles (motion) close electric switch*
- *chemical energy in battery activates an electromagnet (solenoid)*
- *magnet pulls a spinning gear into the flywheel (it also spins this gear)*
- *flywheel turns crankshaft and operates the pistons, rotor, and alternator*
- *gasoline burns, keeping the alternator producing electricity to burn more gasoline*

c. *The output energy is the running engine.*

Baseball Game

a. *The input energy is the pitcher's muscles putting energy into the ball.*

b. *The various energy conversions include the following:*

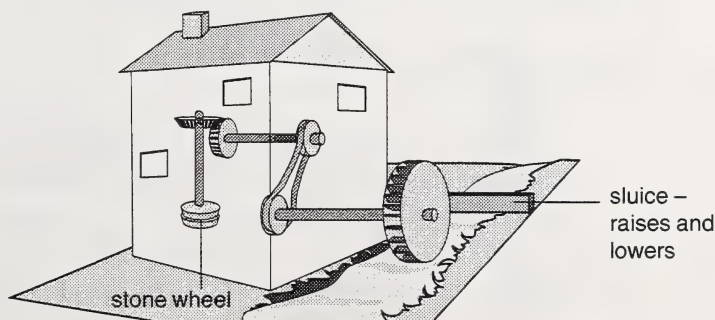
- *pitcher's muscles put ball into motion*
- *batter's muscles put bat into motion*
- *bat's energy is transferred to the ball to change its direction*
- *ball has new motion*

c. *The output energy is the ball having the speed and height to clear the fence.*

- (5 marks) 2. The human body is an energy system. Explain the flow of energy through your body as you run a race. Include the following in your explanation: breathing, keeping cool, eating, running, digesting food, and blood circulation.

Food is eaten. This is the input energy. The food is digested and taken into the blood stream where the nutrients are used by the cells to produce energy and store energy. Breathing supplies oxygen for respiration and removes carbon dioxide. All these processes produce waste heat. The body cools itself by evaporating water (sweating). A small amount of the food energy actually ends up as the running motion of the muscle.

- (4 marks) 3. Here is a diagram of an old mill. It uses a huge stone wheel to grind wheat into flour.



- a. What is the input energy? How is it controlled?

The water's weight, actually gravitational energy, is the input energy. It is controlled by the sluice.

- b. What is the output energy?

The stone wheel turning to grind the wheat is the output energy.

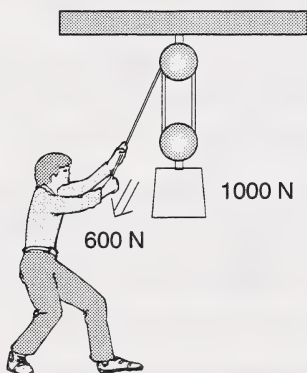
- c. The mill warms up when the wheel is really turning. Why?

Friction in the gears, belts, and stone produce waste heat which warms up the mill.

- d. Suppose this mill is not very efficient. Is that a problem here? Why or why not?

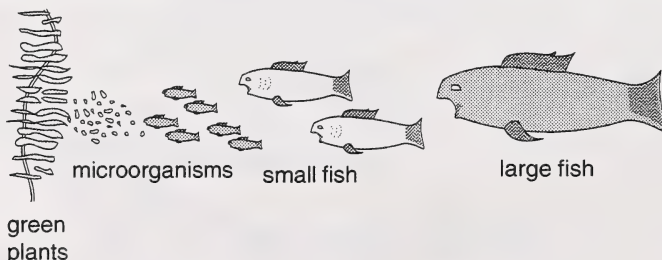
No, low efficiency is not a problem. It is overcome by a steady energy source.

- (5 marks) 4. The person in the following diagram is using a pulley system to lift a 1000 N weight 4 m. He has to pull with a 600 N force and pull his end of the rope down 8 m to do this. Find the efficiency of the pulley system.



$$\begin{aligned}
 \text{Efficiency} &= \frac{\text{work output}}{\text{work input}} \\
 &= \frac{\text{force} \times \text{distance}}{\text{force} \times \text{distance}} \\
 &= \frac{1000 \text{ N} (4 \text{ m})}{600 \text{ N} (8 \text{ m})} \\
 &= \frac{4000 \text{ J}}{4800 \text{ J}} \\
 &= 83\%
 \end{aligned}$$

- (10 marks) 5. Use the following diagram to answer the questions that follow.



- a. The efficiency of a link in a food chain is 10%. How efficient is it for the large fish to get its food?

There are three links from the plants to the large fish. The efficiency is 10% of 10% of 10%. That's 1/10 of 1 percent efficient. Note: The efficiency of photosynthesis isn't included; otherwise you would take 4-7% of this answer.

- b. Why are there fewer large carnivores (meat-eating) fish than smaller plant-eating fish in an ecosystem?

The low efficiency of the links means that many fish lower down on the chain are needed to sustain a few fish higher up. (In this example, there would be millions of microorganisms for fewer small fish too.)

Section 2 Assignment (35 marks)

- (10 marks) 1. Here are three energy systems designed to do something. Explain where the lost energy has gone in each case.

- a. a car (about 20% efficient)

In the car's energy system, most lost energy is heat from friction in the moving parts of the engine and air friction. Some energy is lost as sound as well.

- b. an electric motor (75% efficient)

In the motor's energy system, the wires get hot so some energy is lost as heat. The armature turns, and therefore, there is friction where it is attached as well.

- c. a person (less than 40% efficient)

In the person's energy system, the waste is heat released by the chemical reactions of the body.

- (10 marks) 2. The following diagram shows a perpetual motion machine (a device that will run forever once it's activated). If it's 100% efficient it will never stop. Explain why it won't work as shown. Name four places where it loses energy.

This perpetual motion machine will not work because the ball has lost so much energy that the catcher can't turn the auger enough to raise the ball to the top. The machine won't work unless extra energy is put into the auger.

Places where energy has been lost include the following:

- *Friction in the ramp causes energy to be lost as heat.*
- *The ball makes a sound hitting the catcher so energy is lost as sound.*
- *Everywhere gears touch is another source of friction and more heat loss.*
- *Friction on the second ramp causes energy to be lost as heat.*

- (5 marks) 3. It was a really hot day so Anouk decided to cool the room by opening the refrigerator. She figured that the fridge would take the heat out of the air in the room. Look at the diagram of a fridge and explain why the fridge actually heats the room instead.

Since motors and pumps aren't 100% efficient, they lose some energy as heat. The fridge pulls heat out of the room, but that heat and the heat produced by the motor and pump are exhausted back into the room. The room heats up.

- (10 marks) 4. a. Suppose that you must travel 100 km to your next job. You could drive a car or take a bicycle. Compare the two methods of transportation by finding a rating for each. The rating will be energy per kilometre.

Use this data to make your comparison.

Bicycle (at 20 km/h)	Car
Energy consumption 40.5 kJ/hr	Fuel consumption 10 L/100 km One litre of gas is 32 600 kJ of energy.

The rating for the bicycle may be calculated as follows:

At 20 km/h this trip will take five hours.

$$\text{Energy used} = 40.5 \text{ kJ/hr} \times 5 \text{ hr} = 202.5 \text{ kJ}$$

$$\text{Energy per km} = \frac{202.5}{100} = 2.025 \text{ kJ per km}$$

The ratings for the car may be calculated as follows:

The car uses 10 L of fuel for the 100 km trip.

$$\text{Energy used} = 10 \text{ L} \times 32\,600 \text{ kJ/L} = 326\,000 \text{ kJ}$$

$$\text{Energy per km} = \frac{326\,000}{100} = 3260 \text{ kJ per km}$$

The car uses about 1600 times as much energy as the bicycle.

- b. Which method is best to use in this case? Why?

The car uses much more energy, but the trip will only take about one hour and you won't be tired. The bike trip takes five hours. A reasonably good athlete can do this trip but will be tired when it's over. The car is probably the better choice here.

- c. If the distance to travel was 1 km, which is best? Why?

The bike is better for the shorter trip. It only takes about three minutes and is good exercise.

- d. A good rate of fuel consumption is 10 L/100 km. A car not in good shape mechanically or a large car might use 14 L/100 km. How much more energy does it take now for the 100-km trip?

At 14 L/100 km the car uses four more litres of gas per 100 km. That's $4 \text{ L} \times 32\,600 \text{ kJ/L} = 130\,400 \text{ J}$ more than before.

Note: Answers to b. and c. may not agree as they are opinions. Credit may be given if the supporting reason is good.

Section 3 Assignment: (35 marks)

- (8 marks) 1. Choose **one** renewable and **one** nonrenewable energy source from this chart. For each one explain

- where it comes from
- how to get it
- how to convert it into useful energy
- if there are any pollution problems with it

Nonrenewable	Renewable
coal oil natural gas nuclear	solar (heat) wind water (hydroelectric) biofuels

Coal, oil, or natural gas

- *These sources come from underground deposits and are the remains of fossilized plants (coal) or animals (oil and gas).*
- *People drill for oil and gas and pump them to the surface. Coal is mined above or below ground and carried out on rails.*
- *Coal is burned for its heat value. Oil and gas are burned as well. Other products are also made from them.*
- *Coal, oil, or natural gas create many pollution problems.*
 - *CO emissions*
 - *sulphur emissions (acid rain)*
 - *nitrogen oxides (smog)*
 - *oil spills*
 - *gas blowouts*
 - *coal miner's blacklung disease*

Nuclear

- *The energy source comes from underground uranium deposits.*
- *It is mined underground.*
- *It must be purified for the right kind of uranium (U-235, nuclear fission).*
- *It is used for its heat value.*
- *Pollution problems associated with nuclear sources include the following:*
 - *storing radioactive waste*
 - *nuclear accidents*

Solar (heat)

- *Solar energy comes from direct sunlight.*
- *It's available for collection most everywhere.*
- *In an active system the sun heats a liquid in pipes. The pipes circulate the heat to the parts of a building.*
- *In a passive system the sun heats up windowed areas and convection circulates the heat throughout a building*
- *There are no pollution problems unless pipes burst. Some antifreezes and even CFCs are used in solar collectors, thereby creating possible hazards.*

Wind

- *The sun generates local and global winds.*
- *Windmills pick up the wind energy.*
- *The windmill runs a generator; the electricity produced charges up a storage battery. Windmills may also be directly connected to mechanical devices, e.g., Holland's windmills run pumps directly to pump sea water over the dikes.*

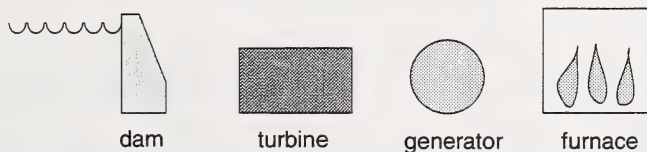
Water

- *Water in mountainous areas is especially useful as an energy source.*
- *In order to get the energy, it is necessary to build a dam to create a large waterfall.*
- *Falling water turns turbines to generate electricity.*
- *There are no big pollution problems, but a dam floods a huge area creating a tremendous environmental impact on the area.*

Biofuels

- The source of biofuels is living things or the products of life processes.
- In order to get biofuels, it is necessary to cut trees, collect marsh gases, and/or “digest” manure.
- Wood and gas are burned for heat value, and sludge and ashes are used as fertilizer or compost.
- Pollution is not a problem if waste is composted. Trees must be replanted or erosion of the previously forested area will ruin the land. Loss of trees (cut) worldwide will increase the greenhouse effect.

- (6 marks) 2. Do some research and draw a diagram of a hydroelectric generating plant and a coal-fired generating plant. Use simple shapes to represent the parts. Explain how each works by labelling the diagrams.



Falling water turns turbine. → Turbine turns generator. → Electricity carried to market.



Coal burned in furnace. → Water turned to steam. → Steam turns turbine. →



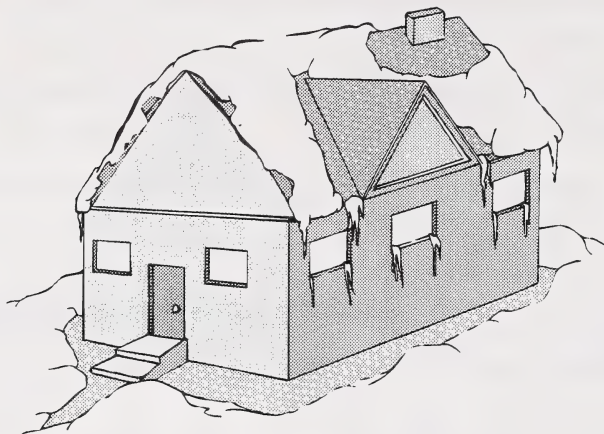
Turbine turns generator. → Electricity carried to market.

- (4 marks) 3. Canada is not self-sufficient in energy; some energy is imported. Name two ways that Canada could become self-sufficient in energy.

Possible ideas for Canada becoming self-sufficient in energy include the following:

- Don't sell any energy until there is enough for Canadians.
- Develop the tar sands, offshore oil deposits, and available hydroelectric sites until Canada is self-sufficient.
- Put conservation plans into effect on a large scale.
- Develop alternate energy sources to supplement the use of fossil fuels.

- (8 marks) 4. Look at the following diagram of a house. It's winter and a 40-cm snowfall came down two days ago. The temperature has been at -8°C or lower since. Find three places where this house is losing heat and suggest a solution to stop or reduce these losses.



Various problems and possible solutions are outlined in the following chart:

Problem	Possible Solutions
<i>There is no snow around chimney so the chimney is losing much heat</i>	<i>Insulate the chimney. Replace the furnace with an energy-efficient model. Put glass windows on the fireplace.</i>
<i>There are icicles on the roof and no snow around edges of gable. The gable is losing heat where it joins roof.</i>	<i>Insulate the connection of the gable to the roof. Re-build the gable with energy-efficient methods.</i>
<i>There is no snow around the house, so the house is losing heat from the basement walls.</i>	<i>Insulate basement walls below the ground line. Insulating the walls to the basement floor is better.</i>
<i>There are icicles on windows so heat loss through windows is occurring.</i>	<i>Caulk all windows. Replace windows with more energy-efficient ones.</i>

- (9 marks) 5. Suppose you are the energy minister of a small country. You must tell your government how to get the energy you need for the people in your country. Here are some facts about your country:

- near the equator, flat country
- inland – there is no port to any ocean
- semi-desert conditions
- very few oil or coal deposits

Write a paragraph that presents your ideas about how to get your energy. Look at all the possible energy types and the energy requirements the people may need.

The needs of the people and country include the following:

- *cooling (a hot climate); very little heating*
- *electricity*
- *transportation fuel*

Ideas about supplying energy requirements include the following:

- *Use solar energy; it should be easily available. Houses can use solar cells for electricity and passive solar ideas for cooling.*
- *Biofuels (methane digesters) may be the only source of fuel. These must be purchased. Buying nuclear power is a possibility if water is available for steam. Hydroelectricity is out of the question.*

TEACHER QUESTIONNAIRE FOR SCIENCE 24

This is a course designed in a new distance-learning format, so we are interested in your responses. Your constructive comments will be greatly appreciated so that a future revision may incorporate any necessary improvements.

Teacher's Name _____ Area of Expertise _____

School Name _____ Date _____

Design

1. The modules follow a definite systematic design. Did you find it easy to follow?

☐ Yes ☐ No If no, explain.

2. Did your observations reveal that the students found the design easy to follow?

☐ Yes ☐ No If no, explain.

3. Did you find the Learning Facilitator's Manual helpful?

☐ Yes ☐ No If no, explain.

4. Part of the design involves stating the objectives in student terms. Do you feel this helped the students understand what they were going to learn?

☐ Yes ☐ No If no, explain.

5. The Learning Facilitator's Manual contains Assignment Booklet questions and answers and a sample test. Did you find these helpful?

☐ Yes ☐ No If no, explain.

6. Did the Follow-up Activities prove to be helpful?

☐ Yes ☐ No If no, explain.

7. Were students motivated to try these Follow-up Activities?

☐ Yes ☐ No If no, give details.

8. Suggestions for computer and video activities are included in the course. Were your students able to use these activities?

☐ Yes ☐ No Comment on the lines below.

9. Were the assignments appropriate?

☐ Yes ☐ No If no, give details.

Teacher's Name _____

Name of School _____ Date _____

10. Did you fax assignments?

☐ Yes ☐ No

11. If you did fax, did you get satisfactory results from using this procedure?

☐ Yes ☐ No If no, give details.

Instruction

1. Did you find the instruction clear?

☐ Yes ☐ No If no, give details.

2. Did your observations reveal that the students found the instruction interesting?

☐ Yes ☐ No If no, give details.

3. Did you find the instruction adequate?

☐ Yes ☐ No If no, give details.

4. Was the reading level appropriate?

☐ Yes ☐ No If no, give details.

Teacher's Name _____

Name of School _____ Date _____

5. Was the work load adequate?

☐ Yes ☐ No If no, give details.

6. Was the content accurate and current?

☐ Yes ☐ No If no, give details.

7. Did the content flow consistently and logically?

☐ Yes ☐ No If no, give details.

8. Was the transition between booklets smooth?

☐ Yes ☐ No If no, give details.

9. Was the transition between print and media smooth?

☐ Yes ☐ No If no, give details.

Teacher's Name _____

Name of School _____ Date _____

Additional Comments

Thanks for taking the time to complete this survey. Your feedback is important to us.

Fax Number: 674-6686

Instructional Design and Development Unit
Alberta Distance Learning Centre
Box 4000
Barrhead, Alberta
T0G 2P0

Teacher's Name _____

Name of School _____ Date _____

International Journal of
Algebra and Combinatorics
Vol. 1, No. 1
January 1991
1-10

Journal of
Algebra
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